PEAT ENERGY FEASIBILITY STUDY

CAT LAKE, ONTARIO

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CAT LAKE, ONTARIO

Prepared for:

Cat Lake Indian Community

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With funding from:

Remote Community Demonstration Program
of Energy, Mines and Resources Canada;
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EXECUTIVE SUMMARY

The Cat Lake Indian Community is located about 180 km north of Sioux Lookout, Ontario and depends on air transport for its supplies. It is not connected to the electricity grid and relies on diesel fuel for its main source of energy. Concern has been expressed about the high cost of diesel fuel and its vulnerability to interruptions in supply.

This study's objectives were:

- to assess the energy needs of the Cat Lake Indian Community;
- to evaluate the peat resource base; and
- to determine whether it is technically and economically feasible to meet the community energy needs by a peat energy conversion centre (PECC).

The study was undertaken for the Cat Lake Indian community with funding from the Remote Community Demonstration Program of Energy, Mines and Resources Canada; Indian and Northern Affairs Canada; and the Ontario Ministry of Energy.

The consultants conducting the study were Rak Engineering Ltd., Maunder and Britnell Engineering Limited and IEC Beak Consultants Ltd.

A profile of the community has been developed and examined in terms of population, education, employment and income. Projections for the community population, housing and required facilities have been carried out for the milestone years 1985, 1990 and 2000. These projections indicate that the Cat Lake population will nearly double by the end of this century with a corresponding increase in the housing units from 74 to 144. The total floor area of the community buildings will increase from 2346 m^2 (1985) to 3751 m^2 (1990) and 4861 m^2 (2000) respectively.

The projected energy needs for a 20 AMP house service scenario at the milestone years indicate an increase from 580,000 kWh consumed annually in 1985 to 1,150,000 kWh by the end of this century. The same projections for a 100 AMP service, which the community desires, would increase the annual consumption from 875,000 kWh in 1985 to about 1,730,000 kWh by the year 2000.

The total annual peat requirements for the recommended 100 AMP scenario and sod peat space heating is estimated to be 5,200 tonnes in 1985, 6,800 tonnes in 1990 and about 8,500 tonnes by the year 2000.

The evaluated peat resource base located within 10 km of the community is in the range of 1,500,000 to 2,000,000 tonnes of fuel grade peat; and it was concluded by the study that only a portion of these deposits would be utilized to meet the projected community energy needs. The estimated capital cost for the proposed peat harvesting facility is in the order of $950,000 with annual operating costs of about $100,000. The cost of peat delivered to a PECC varies from about $35/tonne at the start-up to $20/tonne by the year 2000.

The results of the technical studies indicated that there were several energy system alternatives to meet the community energy needs. The leading candidates were: a diesel generator system located in the community;

connection to Ontario Hydro grid; and a peat energy conversion centre. It was concluded that a peat-fired boiler and steam engine generator system, using proven technology, is entirely feasible.

Environmental and social impacts resulting from the interaction between the proposed activities of the Cat Lake peat development and the social environmental components have been assessed in generic terms. The study notes that some of the changes the proposed development will bring are considered beneficial, others unfavourable. A summary of social and environmental impacts together with possible mitigation measures and suggestions for research needed is presented.

The economic analysis of the recommended energy systems and various sub-system scenarios has been carried out. The options were financially evaluated on the basis of a single government body being responsible for providing, maintaining and operating each complete facility.

Consultant's Conclusion

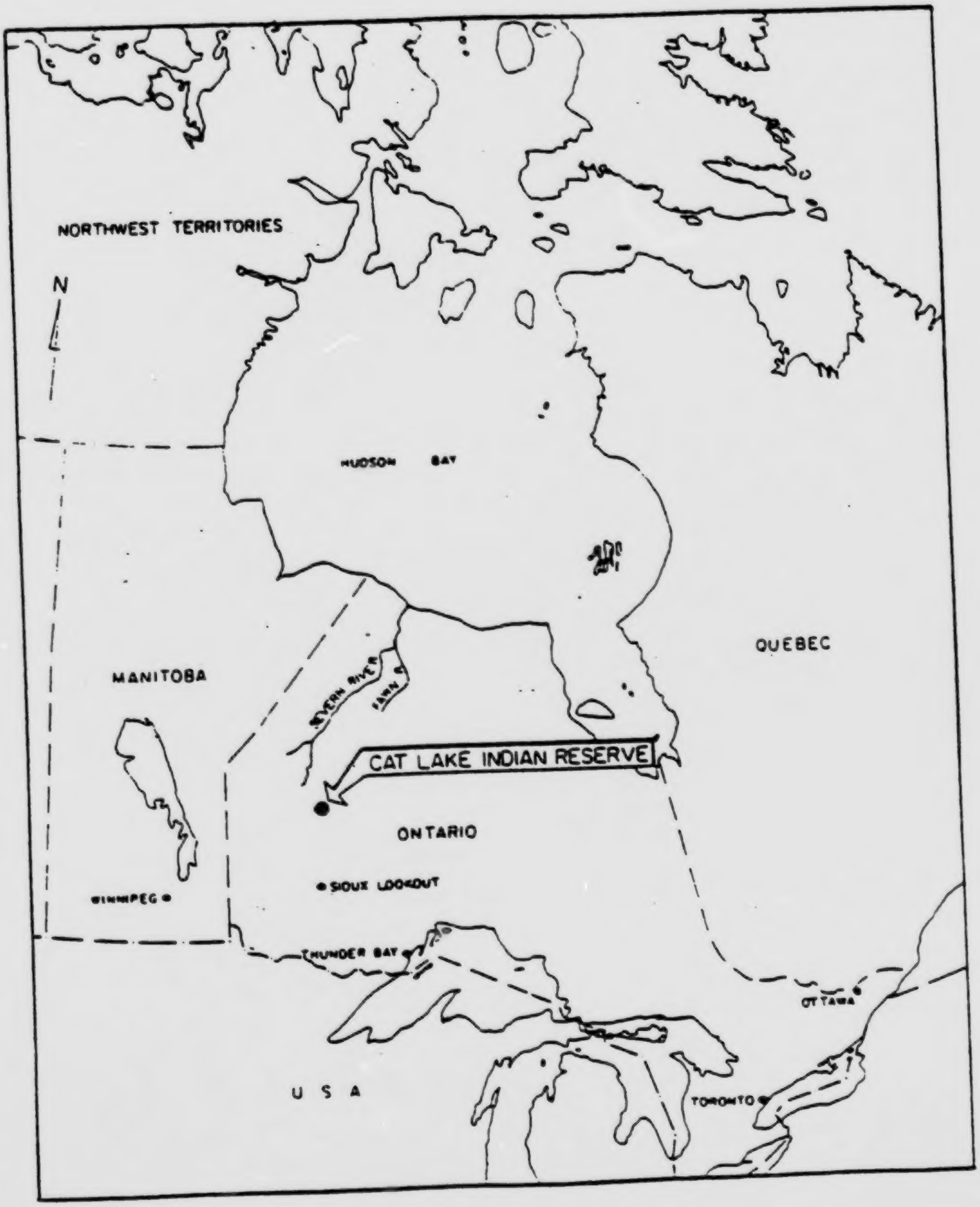
In overall economic terms, the recommended peat-fired steam engine option is superior for the 100 AMP scenario. If implemented, the estimated annual incomes flowing into the community would be $543,000 and $1,212,000 for the milestone years of 1990 and 2000 respectively. In addition to the estimated income benefits, the implementation of the proposed peat energy system also represents a very worthwhile training component for peat harvesting and peat energy conversion centre personnel.

Furthermore, the steam engine option represents a very efficient method of electrical generation for remote community applications. The average annual cost per kWh of $.42 in the year 2000 is about the same as today's average cost of $.40 per kWh in northern community diesel generator facilities. In terms of year 2000 dollars, the cost per kWh is 36% of the projected diesel generator costs.

It was concluded that the Cat Lake Community should utilize the local peat resource base and the available technology to substantially improve the quality of life on the reserve. It is evident that the proposed peat energy system and associated know-how would be beneficial to other remote communities with indigenous peat fuel resources. In some cases, the long term cost savings and social benefits of successful use of such an energy system may spell the difference between proceeding and not proceeding with given electrification projects. More project starts, by themselves, would create much-needed economic benefit to remote communities.

Energy, Mines and Resources Canada's Conclusion

A review by Energy, Mines and Resources Canada has found that the report's central recommendation, the installation of a community-scale peat-fired cogeneration system in the community of Cat Lake, cannot be economically justified. This position is based on an economic and financial analysis of the various technology streams evaluated in the study for the Cat Lake community. (These were: local diesel generator, connection to Ontario Hydro grid, peat gasifier, and peat boiler.) The review revealed that each technology generates a negative net present value, assuming a base case of no central electrification, indicating that the technologies evaluated for Cat Lake are neither financially nor economically viable.


NORTHWEST TERRITORIES
N
HUDSON BAY
QUEBEC
MANITOBA
SEVERN RIVER
FAWN R.
CAT LAKE INDIAN RESERVE
ONTARIO
WINNIPEG
SIOUX LOOKOUT
THUNDER BAY
OTTAWA
U S A
TORONTO

CAT LAKE INDIAN RESERVE
KEY PLAN

Scale	Date	Drawing No
N.T.S.	JAN. 84	1

ÉTUDE DE FAISABILITÉ SUR L'UTILISATION DE LA TOURBE COMME ÉNERGIE À CAT LAKE (ONTARIO)

Résumé

La collectivité indienne de Cat Lake est située à environ 180 km au nord de la collectivité de Sioux Lookout, en Ontario et dépend sur le transport aérien pour ses provisions. Elle n'est pas reliée au réseau électrique et utilise le diesel comme source d'énergie primaire. En ce temps, les coûts élevés du diesel et la vulnérabilité à l'interruption d'approvisionnement ont créé une atmosphère malaisée.

Les objectifs de cette étude étaient:
- d'évaluer les besoins énergétiques de la collectivité;
- d'évaluer les ressources de base de tourbe;
- et de déterminer s'il serait possible techniquement et économiquement de répondre aux besoins énergétiques de la communauté en aménageant un centre de conversion de l'énergie de la tourbe (C.C.E.T.).

Cette étude a été réalisée pour la Bande indienne de Cat Lake à l'aide d'une subvention du Programme de démonstration dans les collectivités éloignées d'Énergie, Mines et Ressources Canada, du ministère des Affaires indiennes et du Nord Canada et du ministère de l'Énergie de l'Ontario.

L'étude a été effectuée par la Rak Engineering Ltd., la Maunder and Britnell Engineering Limited et la IEC Beak Consultants Ltd.

On a élaboré un profil de la communauté qu'on a ensuite étudié en fonction de la population, du niveau d'éducation, des emplois et du revenu. On a également fait des projections de l'accroissement démographique, des besoins en matière d'habitation et des installations requises, pour les années-repères 1985, 1990 et l'an 2000. Selon ces projections, la population de Cat Lake aura presque doublé d'ici la fin du siècle, d'où l'augmentation correspondante du nombre des untiés d'habitation passera de 74 à 144. La superficie totale de plancher des bâtiments communautaires passera de 2 346 m^2 (1985) à 3 751 m^2 (1990) et à 4 861 m^2 (l'an 2000).

Les besoins énergétiques annuels prévus dans un scénario relatif à un service résidentiel de 20 amp. durant les années-repères, établit que ces derniers passeront de 580 000 kWh en 1985 à 1 150 000 kWh à la fin du siècle. Pour le service de 100 amp. demandé par la population, les besoins passeraient de 875 000 kWh en 1985 à environ 1 730 000 kWh en l'an 2000.

Les besoins annuels totaux en tourbe pour assurer le service de 100 amp. et le chauffage des locaux sont évalués à 5 200 tonnes en 1985, 6 800 tonnes en 1990 et environ 8 500 en l'an 2000.

On estime que le capital-ressources en tourbe trouvé dans un rayon de 10 km de l'agglomération se situe entre 1 500 000 et 2 000 000 tonnes de tourbe combustible. Selon l'étude, seule une partie des réserves serait utilisée pour répondre aux besoins prévus de la communauté. L'investissement nécessaire à l'aménagement des installations de cueillette est évalué à 950 000 $ et les coûts annuels d'exploitation seraient de l'ordre de 100 000 $. La tourbe livrée à un C.C.E.T. coûterait entre 35 $/tonne, au début du programme, et 20 $/tonne, en l'an 2000.

Les études techniques ont révélé qu'il existait plusieurs solutions de rechange permettant de répondre aux besoins énergétiques de la communauté: une génératrice diesel, le raccord au réseau d'Ontario Hydro et l'aménagement d'un centre de conversion de l'énergie de la tourbe. Il a été conclu que l'aménagement d'une chaudière alimentée à la tourbe et d'un moteur à vapeur, selon les techniques existantes, était tout à fait faisable.

On a également procédé à l'étude générale des répercussions environnementales et sociales de l'interaction entre les activités proposées dans le cadre de la mise en valeur de la tourbe de Cat Lake. Selon l'étude, certains des changements apportés par le projet seront bénéfiques et d'autres le seront moins. Il y a eu présentation d'un bilan des incidences sociales et environnementales, d'un énoncé des mesures permettant de les atténuer et des suggestions de recherche.

Une analyse économique des divers systèmes et sous-systèmes énergétiques recommandés a également été réalisée. Les solutions ont été évaluées du point de vue financier, en supposant qu'un seul palier de gouvernement serait responsable de la prestation, de l'entretien et de l'exploitation de chacune des installations.

CONCLUSION DU CONSULTANT

En termes économiques globaux, le système de la chaudière alimentée à la tourbe et le moteur à vapeur conviendrait mieux au scénario de 100 amp. Si cette solution était choisie, les recettes annuelles réalisées par la communauté serait de 543 000 $ et de 1 212 000 $ en 1990 et l'an 2000 respectivement. De plus, les installations pourraient servir en grande partie à la formation du personnel chargé de l'extraction de la tourbe et de l'exploitation du centre de conversion.

En outre, les moteurs à vapeur sont très efficaces pour produire de l'électricité dans des collectivités éloignées. Le coût annuel par kWh serait de 0,42 $ en l'an 2000, soit environ la même chose que pour la production actuelle des génératrices diesel actuellement utilisées dans le nord, soit 0,40 $ par kWh. En dollars de l'an 2000, le coût par kWh représente 36 % des coûts prévus pour les génératrices diesel.

Il a été conclu que les habitants de la réserve de Cat Lake devraient se servir de leurs ressources en tourbe et des techniques actuelles pour améliorer considérablement leur qualité de vie. Il est évident que le système proposé, avec tout le savoir-faire qui peut en découler, serait bénéfique aux autres collectivités éloignées dotées de telles ressources. Dans certains cas, les économies à long terme et les avantages sociaux pourraient fort bien être le facteur qui déterminera l'implantation de l'électricité dans ces régions. De plus, la mise en oeuvre de projets additionnels pourrait engendrer les retombées économiques dont les collectivités éloignées ont tant besoin.

CONCLUSION D'ÉNERGIE, MINES ET RESSOURCES CANADA

D'après une revue entreprise par Énergie, Mines et Ressources Canada, il a été conclu que la recommandation centrale du présent rapport, l'installation à Cat Lake d'un système de co-génération utilisant un brûleur à tourbe et moteur à vapeur à petite échelle, ne peut être justifiée économiquement. Cette position est basée sur une analyse économique et financière de divers possibilités évaluées dans l'étude pour la collectivité de Cat Lake (ces possibilités étaient: générateur diesel local, raccord avec le réseau de l'Hydro Ontario, gazéificateur de tourbe et chaudière). La revue a révélé que chaqu'une des technologies produit une valeur présente négative, supposant un cas de base sans électrification centrale, indiquant qu'aucune des technologies évaluées pour Cat Lake est financièrement ou économiquement viable.

ADDENDUM

Review of Peat Energy Feasibility Study, Cat Lake, Ont.

by

Energy, Mines and Resources Canada

Following the completion of the Cat Lake Peat Energy Feasibility Study, a technical review of the final report was undertaken by Energy, Mines and Resources Canada. This review found that the report's central recommendation, the installation of a community-scale peat-fired cogeneration system in the community of Cat Lake, cannot be economically justified. This position is based on an economic and financial analysis of the various technology streams evaluated in the study for the Cat Lake community. The review revealed that each technology alternative generates a negative net present value, assuming a base case of no central electrification, indicating that the technologies evaluated for Cat Lake are neither financially, nor economically viable.

Economic and Financial Review

This review provides a financial and economic analysis for the various technology streams proposed for the Cat Lake Community. The data used was derived from the Cat Lake Peat Energy Feasibility Study prepared by L.J. Rak Engineering Limited. Assumptions used for the financial analysis are consistent with those employed in the study and include:

Discount Rate:	15%
Life Cycle:	15 years
Tax Rate:	0

In the present review, a distinction is made between a financial and economic analysis.

The financial analysis in this review consisted of calculating the net present value (NPV) for each energy technology alternative. The NPV method discounts cash flows to the present, using the minimum acceptable rate of return as the interest rate. A positive NPV for any technology stream implies a worthwhile project, where cash inflows exceed cash outflows over the life of the project. A negative NPV implies the inverse. In general, a project generating a negative NPV would not normally be pursued.

Often projects, which cannot be financially justified, are supplemented with public monies to increase the attractiveness of the investment by generating a positive NPV. As an indication of the feasibility of expending public monies, a social benefit-cost analysis is often performed. An economic analysis that uses social benefit-cost criteria that results in a negative NPV implies that, from a strict economic perspective, the expenditure of public monies would not be justified.

In the present review, the economic analysis uses a social discount rate of 7% as recommended by Treasury Board.

Table 1 provides values for the NPV's determined by the present financial and social benefit analyses. Brackets denote a negative NPV.

TABLE 1: SUMMARY OF FEASIBILITY OF ELECTRIFICATION OPTIONS

TECHNOLOGY	CAPITAL COST	ANNUAL OPERATING COST	ANNUAL REVENUE	NPV PRIVATE	NPV SOCIAL
DIESEL					
20 AMP	1,281,132	243,716	98,836	(2,128,299)	(2,600,687)
100 AMP	1,304,672	432,409	153,432	(2,935,954)	(3,845,571)
GRID					
20 AMP	5,207,472	49,984	98,836	(4,921,816)	(4,762,532)
100 AMP	5,231,012	86,392	153,432	(4,839,004)	(4,620,417)
PEAT GASIFIER					
20 AMP	3,697,472	474,540	200,836	(5,297,920)	(6,190,344)
100 AMP	5,489,012	516,570	255,432	(7,015,983)	(7,867,434)
PEAT BOILER					
20 AMP	3,268,472	436,260	200,836	(4,645,083)	(5,413,694)
100 AMP	3,667,012	462,337	255,432	(4,876,862)	(5,551,485)

As Table 1 indicates, all options have a negative net present value compared to the present situation of no central electrification system. Without any technology yielding a positive net present value, it is implied that no action should be taken. However, from a social point of view a certain standard of living is expected, in this case centralized electricity. The community of Cat Lake has expressed a need for a centralized electrical system. The majority of generation systems located in isolated communities are diesel. Therefore, a base case of a 20 amp diesel generating facility was assumed. All other alternatives were analyzed on an incremental basis (see Tables II and III). This marginal analysis clearly reflects the viability of the various options. In relation to the diesel service, all the other alternatives generate negative net present values indicating investment in these alternatives is not economically justified.

TABLE II: MARGINAL COST ANALYSIS: 20 AMP SERVICE

TECHNOLOGY	MARGINAL CAPITAL COST	MARGINAL ANNUAL OPERATING	MARGINAL ANNUAL REVENUE	NPV SOCIAL	NPV PRIVATE
BASE CASE DIESEL - 20 AMP	1,281,132	243,716	98,836	0	0
ALTERNATIVES GRID - 20 AMP	3,926,340	-193,712	0	(2,793,517)	(2,162,028)
PEAT GASIFIER	2,416,340	230,824	102,000	(3,169,621)	(3,589,657)
PEAT BOILER	1,987,340	192,544	102,000	(2,516,784)	(2,813,007)

TABLE III: MARGINAL COST ANALYSIS: 100 AMP SERVICE

TECHNOLOGY	MARGINAL CAPITAL COST	MARGINAL ANNUAL OPERATING	MARGINAL ANNUAL REVENUE	NPV SOCIAL	NPV PRIVATE
BASE CASE DIESEL - 100 AMP	1,304,672	432,409	153,432	0	0
ALTERNATIVES GRID - 100 AMP	3,926,340	-346,017	0	(774,847)	(1,903,050)
PEAT GASIFIER	4,184,340	84,161	102,000	(4,021,864)	(4,080,029)
PEAT BOILER	2,362,340	29,928	102,000	(1,705,914)	(1,940,908)

The 20 amp and 100 amp services were disaggregated for the marginal analysis because they are not directly comparable options. The quality of service with the 100 amp system is superior to the service with the 20 amp system. However, the price consumers are willing to pay for this quality cannot be economically quantified. Assuming that 20 amp diesel generation is the base case, the social cost of expanding to a 100 amp service may be justified on the basis of the quality of living.

The results in Table II are quite interesting. The preference between grid connection and the peat boiler on a net present value basis depends upon the investment perspective, that is the discount rate. From a societal viewpoint the boiler system has a lower negative net present value while for a private investor grid connection would be preferred. This result occurs because grid connection has higher initial costs, which is weighted highly from a societal view, and lower annual costs. The peat boiler has a lower initial cost and higher annual payments (which reflect higher in the private case). Despite this apparent discrepancy (which could lead to difficulty in the choice of investment) the issue is irrelevant. Both investments are not economically, or financially sound.

In conclusion, it is readily observed from these tables, that peat generated electricity is not an economically viable option compared to diesel or even grid connection.

2.0 Introduction

The Cat Lake Indian Community is located about 180 km north of Sioux Lookout, Ontario and depends on air transport for its supplies. It is not connected to the electricity grid and relies on diesel fuel for its main source of energy. Concern has been expressed about the high cost of diesel fuel and its vulnerability to supply interruptions.

2.1 Study Objectives

The objectives of this study were:

- To develop a community profile including both the existing and projected population, employment, education, housing and community facilities; and corresponding energy needs.
- To select and evaluate the locally available peat deposits as a potential long-term alternative energy source.
- To carry out a technical feasibility study including selection and evaluation of design alternatives, review of available technology and an electrification/heating system selection.
- To define and address the corresponding social and environmental concerns including site-specific impacts and potential mitigative measures.
- To carry out financial and economic analysis including capital, operating and generation costs and a life-cycle costing of system alternatives.
- To provide recommendations for the system development including definition of areas requiring further research.

2.2 Scope and Limitations of the Study

The scope of the study was limited to a general review of the essential pre-planning and investment issues. Specific items of interest were:

- Community profile and definition of needs.
- Evaluation of resource base.
- Technical feasibility study of the proposed design alternatives.
- Social and environmental concerns.
- Financial and economic analysis of system alternatives.

The study was necessarily limited by:

- Time and budgetary constraints.
- Incomplete data base, particularly with regard to the still-emerging peat technology, equipment cost and site-specific environmental concerns.

2.3 Methodology

The work carried out in this study could be subdivided into four major areas, namely (1) community and resource base assessment, (2) technical feasibility study, (3) definition of social and environmental concerns, and (4) financial and economic analysis.

To develop the community profile, a site visit including in depth interviews and a task-specific questionnaire were carried out. The results of this task are presented in the Progress Report - Part 2 and summarized in Section 3; similarly, the resource base evaluation was carried out with community participation, and standard peat exploration methods were utilized as described in Part 1 - Progress Report and Section 5.

The technical feasibility study of the selected design and technology alternatives, together with the systems selection, was based on a review of pertinent technical literature and consultations with equipment manufacturers and the members of the study Review Board. The results are presented in the Progress Report - Parts 3 and 4 and summarized in Sections 4, 6 and 7.

The assessment of the social and environmental issues arising from the proposed development is basically generic. The anticipated site-specific impacts and recommended mitigative measures, however, are presented in the Progress Report - Part 5 and summarized in Section 8.

An inherent part of the study was the financial and economic analysis of system alternatives including capital, operating and generation costs. The financial analysis is presented in the Progress Report - Part 6 and summarized in Section 9. It includes a life-costing of system alternatives.

Section 10 of the report gives conclusions based on the work carried out, and recommendations for further system development.

The study was funded by: the Remote Community Demonstration Program of Energy, Mines and Resources Canada; Indian and Northern Affairs Canada; and the Ontario Ministry of Energy.

3.0 PROFILE OF THE CAT LAKE INDIAN COMMUNITY

3.1 General

Cat Lake Reserve is a community of approximately 400 persons located on the shores of Cat Lake which is 180 km north of Sioux Lookout.

The community is accessible by float plane in the summer and ski equipped planes in the winter. A new airport is under construction and is scheduled for completion in 1985. There are no year-round roads to the Reserve although a winter road has occasionally been opened for transporting heavy equipment as was the case during the winter of 82/83 for transport of the MTC equipment for the airport construction.

3.2 Community Survey

3.2.1 Population and Age Distribution

1981 Statistics Canada figures indicate a 1981 Band population of 301 (1981 Census indicates 328 people within three miles of Cat Lake), while Band records indicate a current population of about 415 on the Reserve plus 16 on Crown land near the Reserve. Since 1971, there has been a constant and substantial population increase of about 6% per year. The rate of increase between 1976 and 1981 reduced slightly to 5.5 %.

Compared to all of Ontario the population in 1981 was very young with a disproportionate number of people below the age of 18 and a corresponding lower representation in the older age groups. The distribution is shown in Table 1 which follows.

TABLE NO. 1

AGE DISTRIBUTION CAT LAKE 1981

AGE	CAT LAKE			ONTARIO	
	NO.	%		%	
5	70	21.3	59.4%	6.9	27.5%
5-9	55	16.8		7.2	
10-14	40	12.2		7.8	
15-17	30	9.1		5.6	
18-20	15	4.6		5.7	
21-24	15	4.6		7.3	
25-29	20	6.1		8.5	
30-34	20	6.1		8.4	
35-39	10	3.0		6.7	
40-44	5	1.5		5.7	
45-49	10	3.0		5.4	
50-54	10	3.0	9.0%	5.4	24.7%
55-59	5	1.5		5.2	
60-64	5	1.5		4.1	
65-69	5	1.5		3.5	
70+	5	1.5		6.5	

Source: 1981 Census

Note: Population numbers are randomly rounded up or down to "5" or "0". As such they will not add to the 1981 Census population of 328.

As would be expected with an age profile predominated by children, a very large proportion, 67.1% of the population, is single as compared to 42.7% for Ontario.

The household size is very large at 5.5 (average number of children 3.9), or almost twice the average size for the province. With a younger skewed age structure, one would expect young household maintainers. As shown in Table 2 a very large percentage of household maintainers are less than 25 years of age with most of the household heads being male.

TABLE NO. 2

AGE DISTRIBUTION HOUSEHOLD MAINTAINERS 1981

	CAT LAKE		ONTARIO
AGE	**NO.**	**%**	**%**
25	10	16.7	7.1
25-34	15	25.0	23.6
35-44	10	16.7	19.4
45-54	10	16.7	17.3
55-64	5	8.3	15.2
65 +	10	16.7	17.5

Notes: see previous Table

It is interesting to note from the 1981 Census that, notwithstanding the perceived lack of employment opportunities in this area, 74.5% of the people five years of age and older are classified as non-movers, meaning that they also lived in the community in 1976. Thus, the area has a stable profile indicating that, with the young age distribution, significant increases in population can be expected over the short to medium term in Cat Lake. The relative isolation of this Reserve will ensure that most will choose to remain in the community. Survey response supports this fact in that 95% of respondents expected to stay in Cat Lake, while 97% of respondents expected that other family members would stay in the community as well.

3.2.2 Education, Employment and Income

The education profile shows a large concentration of the population (15 and over) with less than Grade 9 education.

EDUCATION PROFILE CAT LAKE 1981

	NO.	%
Less than Grade 9	105	63.6
Grade 9 - 13	40	24.2
Other Non-University	15	9.1
Some University	5	3.1
University Degree	0	0.0

There are few job opportunities on the Reserve. Permanent jobs for Band members are limited to the Band office staff and the Bay Store. As a result of the approximate 50 families living in Cat Lake (as compared to the number of households) about 90% had neither husband nor wife formally employed. It is expected that a similar situation exists for the non-family households.

Because job opportunities are known to be scarce, only 16% of those eligible for employment (15 and over and not at school) are formally in the labour force. Since the Census was done during the summer when some seasonal jobs are normally available, (house construction, MTC repairs), it is expected that the employment rate noted is the high for the year and that normally the employment rate is significantly lower.

Employment distribution by industry division was as follows: (1981 Census)

TABLE NO. 3

EMPLOYMENT DISTRIBUTION BY INDUSTRY DIVISION

CAT LAKE 1981

Industry Division	**%**
Agriculture	0.0
Forestry	0.0
Fishing-Trapping	0.0
Mines-Quarries	0.0
Manufacturing	0.0
Construction	16.7
Transportation/Communication	0.0
Trade	0.0
Finance/Real Estate	0.0
Business/Personal Services	16.7
Public Administration	33.3
Industry Not Stated	33.3

Note: Total Employment is plus or minus 20 persons and percentages will be distorted as a result of random rounding.

As a result of the very low levels of employment in the community, household incomes are correspondingly low with a full 2/3 indicating a household income of less than $5000. Standards of living are supplemented through hunting, fishing and garden farming.

HOUSEHOLD INCOME DISTRIBUTION CAT LAKE 1980

Household Income (1980)	**No.**	**%**
< $5000	40	66.7
$5000 - $ 9999	10	16.7
$10000 - $14999	5	8.3
$15000 - $19999	0	0.0
$20000 - $24000	5	8.3
TOTALS	60	100.0

Average Household Income $4260

Various forms of government assistance are the major source of income in the community. Due to the isolation of this Reserve it is unlikely that this situation will change.

Although most residents intended to stay in Cat Lake, few saw any permanent job opportunities locally (26%). However, a significantly larger population see the opportunity for seasonal jobs (67%). It is expected that these comments relate to the construction jobs that will become available during airport construction.

3.3 Community Projections - 1985, 1990 and 2000

3.3.1 - Population

Three sources of population growth projections for the community are currently available. In Appendix 'A' the numbers from the three sources are developed and then plotted in graph form. Taking this data into consideration we believe that the population projection curve selected for this peat feasibility study as shown in Appendix A is reasonable. It results in projected populations for the beginning of the study Milestone Years as follows:

Study Milestone Year	**Projected Population**
1985	425
1990	535
2000	750

3.3.2 - Housing

Appendix 'B', Housing Projections contains the references and the rationale for the housing projections. For the beginning of the Study Milestone Years the projected houses are as follows:

Study Milestone Year	**Projected Houses**
1985	74
1990	106
2000	144

The following graph illustrates the relationship between the selected population and housing projections for the years under consideration in this study.

CAT LAKE INDIAN RESERVE
POPULATION & HOUSING PROJECTIONS

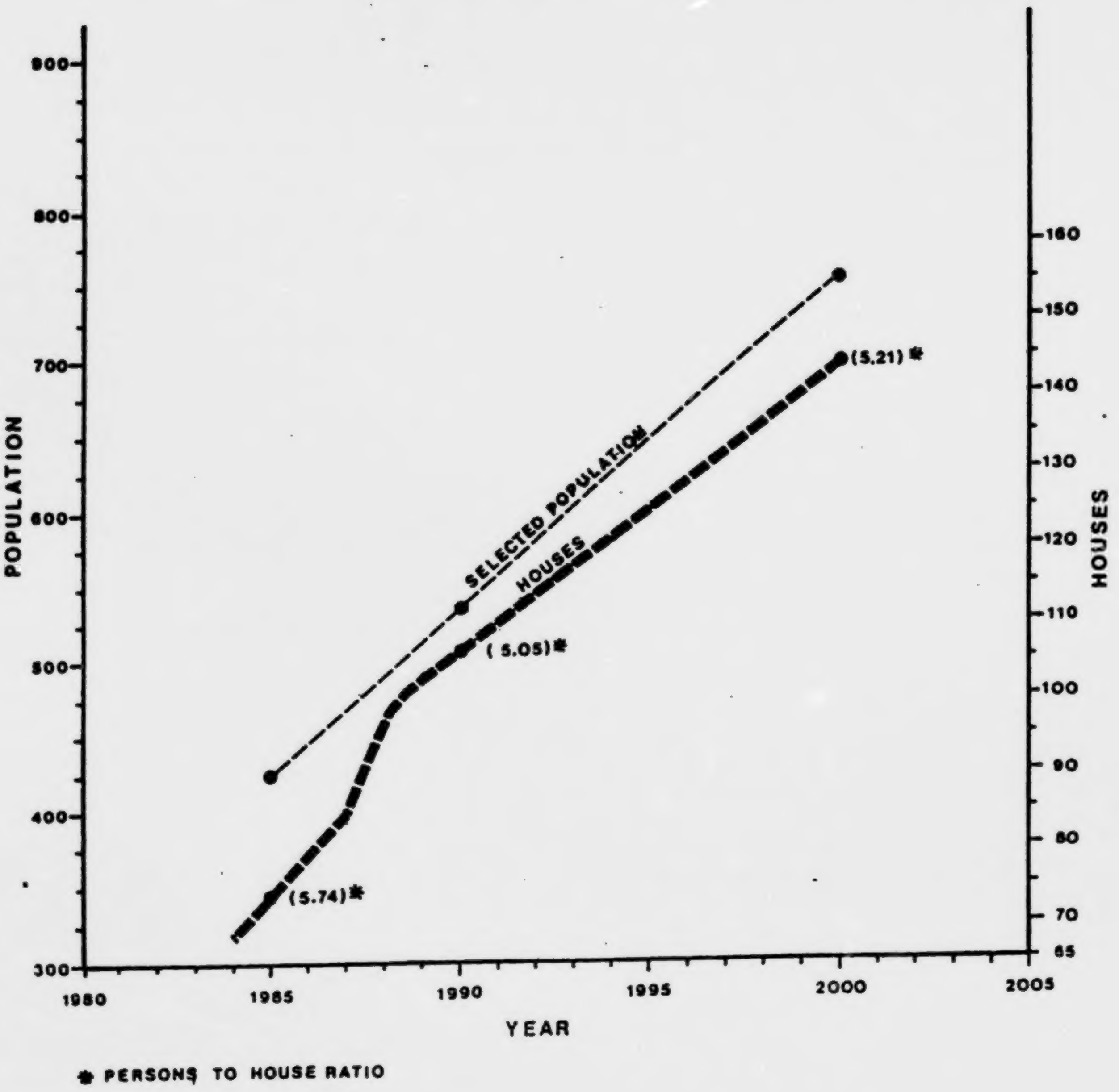


FIGURE 1

3.3.3 Community Facilities

The following inventory of existing community facilities as well as those projected to be completed by 1985 came from the following sources:

- DIAND "Capital Asset Inventory System" summary sheets dated February 17, 1983
- "Cat Lake Indian Reserve Community Planning and Housing Infrastructure Servicing Feasibility Study"(Draft) by Marshall Macklin Monaghan Limited (MMM) dated March, 1984. Please note that the housing and building projections have been utilized without judgements being made regarding the likelihood of the facilities being realized.
- Direct consultation with DIAND
- Remote Community Data Base, Volume 2, September 1982, Ontario Ministry of Energy.

TABLE NO. 4

INVENTORY OF EXISTING COMMUNITY FACILITIES

Buildings (Beginning of 1985)	Size (m^2)	Heated (*=yes)	Electrical Generation Source
School with Clinic	696	*	School Diesel Generator
Teacherage (3)	251	*	" " "
School Pump House	20	*	" " "
Recreation Hall (Community)	223	*	" " "
Health Centre (NHW)	46	*	" " "
Warehouse/Agency Cabin	116	*	" " "
2 Churches	251	*	" " " (1 Church only)
Band Office	113	*	School Diesel Generator in winter & separate dedicated unit in summer
Mamawe Nowlin Store,Say	93	*	-
Hudson's Bay Store and Res.	186	*	Hudson's Bay Co. Diesel Generator
Pool Hall	37	*	-
Bell Compound (Telesat Station)	-		Bell Diesel Generator
Radio Station	37	*	
Band Warehouses(2)	142	-	-
Repair Shop	37	*	
Storage Shed	26	-	-
Diesel Shed	56	-	-
Pump House	16	-	-

TABLE NO. 5

SCHEDULE OF PROPOSED COMMUNITY FACILITIES - 1985 TO 1990

Buildings (Beginning 1990)	Size (m^2)	Heated (*=Yes)	Centralized Electrical Generation Source (* = Yes)
Airport	56	*	*
Water Supply	56	*	*
Child Care Centre	93	*	*
Medical Clinic/ Nursing Station	100	*	*
Senior Citizens Complex (8 units)	200	*	*
Laundromat	50	*	*
Fire Hall(Truck Bay & Training Room)	100	*	*
Hockey/Skating Rink	-	-	-
Indoor Gymnasium	600	*	*
Works Yard/3 Bay Maintenance Garage	150	*	*
Fuel Depot(Bulk Tank Surrounded by Chain Link Fence)	-	-	-
Peat Energy Conversion Centre		*	*

Note: The above list would be supplementary to the previous 1985 community building list as shown in Table 4.

TABLE NO. 6

SCHEDULE OF PROPOSED COMMUNITY FACILITIES - 1990 TO 2000

Buildings (Beginning 2000)	Size (m^2)	Heated (*=Yes)	Centralized Electrical Generation Source (*=Yes)
Drop-In Centre	130	*	*
Coffee Shop	70	*	*
Band Co-Operative Store c/w two warehouses	410	*	*
Bakery	75	*	*
Motel (equivalent to 3 B.R. House)	100	*	*
Police Station	85	*	*
Craft Centre	160	*	*
Bingo/Film Hall	80	*	*

Note: The above list would be supplementary to the previous 1985 and 1990 community building lists as shown in Tables 5 and 6.

4.0 COMMUNITY ENERGY REQUIREMENTS

4.1 General

The purpose of this Section is to develop the peat requirements from the local peat resource for electrification and space heating of the Cat Lake Indian Reserve for the three selected design years 1985, 1990 and 2000.

For purposes of peat demand for electrification both 20 Amp and 100 Amp services will be evaluated to provide quantities of peat required for a Peat Energy Conversion Center (P.E.C.C.).

For purposes of space heating with peat it has been assumed that all houses and community buildings will be heated with peat burned in varied stove types and furnaces.

4.2 Electrification

4.2.1 Selection of Scenarios

The ultimate selection of 20 Amp versus 100 Amp service to houses and community buildings becomes a rather complicated issue which will not be determined by free market supply/demand relationships. Based on an Ontario Hydro remote community operated system it is possible for a house to be connected for either service level, but the charge for each kWh of 100 Amp service is approximately 4 times the price for 20 Amp service (i.e. 11.8 cents versus 44.2 cents per kWh). This would normally discourage most families aspiring for 100 Amp service, but the DIAND "Draft Policy" which would limit the electricity consumption charges per house to $130 per year with all charges in excess borne by DIAND would tend to neutralize the high kWh charges for 100 Amp service. This policy will likely encourage consumers to opt for the 100 Amp service. This, combined with the natural desire of the residents to maximize the benefits from a convenient local energy source, makes it logical to evaluate a 100 Amp scenario. The foregoing factors make it reasonable to evaluate a scenario which would allow the community residents to benefit from the local energy resource by potentially having more electrical power available to them at acceptable cost.

4.2.2 - Design Criteria

Certain design criteria need to be based on analogous operating experience rather than the application of physics equations. The table below represents "experience" with respect to "House Consumption" and "Diversity Factor" while "Potential Demand" is derived from normal electrical relationships.

	Electrical Service **20 Amp**	 **100 Amp**
Annual House Consumption	6000 kWh	10,000 kWh
Potential Demand	2.4 kW	12 kW
Diversity Factor (utilization)	50%	50%
Demand per residence	1.2 kW	6 kW

The method used to estimate the annual electrical consumption of the community buildings is as follows:

> From the "Remote Community Data Base Volume 2," dated 1982, the total annual community fuel oil consumption is identified to be 116,826 litres and it is further stated that 44% of this was used for electrical generation. This equals 51,403 litres.
>
> The Ontario Hydro northern community electrical generation data for 1981, included in the Remote Community Data Base, Volumes 1 and 2 (Ontario Ministry of Energy), indicates that each litre of oil results in an average 2.25 kWh of measured electrical consumption. Thus, the 51,403 litres used for power generation would result in 51,403 x 2.25 = 115,657 kWh being consumed. This power was used by:

School plus Clinic	696 m^2
Teacherages	251
Pump House	20
Warehouse/Agency Cabin	116
Band Office	113
Store and Residence	186
1 Church	125
Health Centre (NHW)	46
Recreation Hall	223
Bell Telesat Station	-
Total area	1,776 m^2

The Telesat Station is a 1500 watt unit and we have assumed a continuous load of 1 kW or 8,760 kWh/yr. Adjusting the community power generation for the Telesat facility which is not typical of northern community buildings, results in a building area average usage of

$$\frac{115{,}657 - 8{,}760}{1{,}776} = 60.2 \text{ kWh/m}^2\text{/yr.}$$

The average annual electrical consumption figure for each community building was obtained by applying the above derived usage rate to the building areas. The resulting kWh consumption was used as the basis for calculating the electrical demand in kW for each facility. To establish an average hourly consumption rate it has been assumed that annual consumption was spread over 75% of the hours in the year . This hourly rate has been doubled, (i.e. the previously assumed diversity factor was 0.5), to produce a demand figure. The calculation of the demand factor is shown below:

$$\frac{60.2 \times 2}{365 \times 24 \times 0.75} = .018 \text{ kW/m}^2$$

It is recognized that the actual consumption will vary considerably between buildings, but there is sufficient diversification among the buildings that this should prove to be suitably accurate in projecting the total community building consumption.

The electrical generation and supply systems would be comparable to the services provided by Ontario Hydro when they provide power to northern communities which are not on the grid and accessible by air only. This standard of service can be summarized as follows:

a) 600 volt generation facility would be housed in a dedicated building and would consist of three generators each with a Diesel driver and all the necessary control panels and switch gear. The generators are sized such that the largest is capable of supplying the full load and the other two are staggered in size, but with the combined capacity of the large unit.

b) The distance between the Diesel Generator Plant and the community would be evaluated by Ontario Hydro to establish the transmission voltage.

c) 120/240 volt distribution system to houses and buildings.

d) The initial installed system would be selected for the projected load for a shorter term of say 5 years. When the community consumption can no longer be satisfied by the larger Diesel Generator Set then the smallest unit is replaced by a unit sized for the present and new short term projected load. This procedure is repeated as growth dictates.

4.2.3 - 20 Amp Service Scenario

4.2.3.1 - Housing Electrical Projections

TABLE NO. 7

HOUSING ELECTRICAL PROJECTIONS

Milestone Year (1)	No. of Houses (2)	kw Demand per House (3)	Total kW Demand (4)=(2)x(3)	kWh of Consumption (5)	Annual kwh of Consumption (6)=(2)x(5)
1985	74	1.2	88.8	6,000	444,000
1990	106	1.2	127.2	6,000	636,000
2000	144	1.2	172.8	6,000	864,000

1.2.3.2 - Community Building Electrical Projections

TABLE NO. 8

COMMUNITY BUILDING ELECTRICAL PROJECTIONS 1985

Year 1985 Buildings	**Size (m^2)**	**Demand (kW)**	**Annual Consumption kWh**
School with Clinic	696	12.53	41,899
Teacherage (3)	251	4.52	15,110
Diesel Shed	56	1.01	3,371
Pump House (1974)	20	.36	1,204
Storage Shed	26	.47	1,565
Warehouse/Agency Cabin	116	2.09	6,983
Band Office	113	2.03	6,803
Community Hall	223	4.01	13,425
Pump House (1980)	16	0.29	963
Warehouse (1)	71	1.28	4,274
Warehouse (2)	71	1.28	4,274
Repair Shop	37	0.67	2,227
2 Churches	251	4.52	15,110
2 Stores	186	3.35	11,197
Radio Station	37	0.67	2,227
Nursing Residence	46	0.83	2,769
Pool Hall	37	0.67	2,227
1985 Community Building Totals		40.58 **kW**	135,628 **kWh**

Note:
The annual consumption numbers have all been calculated on the basis of the average 60.2 $kWh/m^2/year$ factor which was calculated on the basis of historical consumption data in Section 4.2.2. The average demand calculation is also explained in the same section. This means that there can be specific building types where the relationship will appear questionable, but the process of averaging to arrive at milestone year totals would be consistent with historical electrical power usage and is reasonable for this study. This note also applies to the 1990 and 2000 community buildings electrical projection tables which follow.

TABLE NO. 9

COMMUNITY BUILDING ELECTRICAL PROJECTIONS - 1990

Year 1990 Buildings	Size (m^2)	Demand (kW)	Annual Consumption kWh
1985 TOTAL PER PREVIOUS TABLE		40.58	135,628
Airport Building	56	1.01	3,371
Water Supply	56	1.01	3,371
Child Care Centre	93	1.67	5,599
Medical Clinic/ Nursing Station	100	1.8	6,020
Senior Citizens Complex (8 units)	200	3.6	12,040
Laundromat	50	0.9	3,010
Fire Hall (Truck Bay and Training Room)	100	1.8	6,020
Hockey/Skating Rink	-		-
Indoor Gymnasium	600	10.8	36,120
Works Yard/3 Bay Maintenance Garage	150	2.7	9,030
Fuel Depot(Bulk Tank Surrounded by Chain Link Fence)	-		-
1990 Community Building Totals		65.87 kW	220,209 kWh

TABLE NO. 10

COMMUNITY BUILDING ELECTRICAL PROJECTIONS - 2000

Year 2000 Buildings	Size (m^2)	Demand (kW)	Annual Consumption kWh
1990 TOTAL PER PREVIOUS TABLE		65.87	220,209
Drop-In Centre	130	2.34	7,826
Coffee Shop	70	1.26	4,214
Band Co-Operative Store c/w two warehouses	410	7.38	24,682
Bakery	75	1.35	4,515
Motel (Equivalent to 3 B.R. house)	100	1.8	6,020
Police Station	85	1.53	5,117
Craft Centre	160	2.88	9,632
Bingo/Film Hall	80	1.44	4,816
2000 Community Building Totals		85.85 kW	287,031 kWh

4.2.3.3 - Equivalent Peat Requirements

The foregoing Sections 4.2.1 and 4.2.2 developed the projected electrical consumptions for houses and community buildings for the study Milestone Years of 1985, 1990 and 2000. The conversion of peat to electrical energy would be approximately as follows:

1 kg sod peat at 40% moisture = 21.1 x 0.6 x 0.14

= 1.77 MJ

where:

$$\text{Average H.H.V. per Section5.0} = \frac{9{,}510+8{,}827+8{,}992+9{,}002}{4} = 9{,}083\ \text{Btu/lb.}$$

1 Btu = .001055 MJ

1 kg = 2.205 lb

$$\text{H.H.V.} = 9{,}083\ \frac{\text{Btu}}{\text{lb}} \times .001055\ \frac{\text{MJ}}{\text{Btu}} \times 2.205\ \frac{\text{lb}}{\text{kg}}$$

= 21.1 MJ/kg

$$\text{Peat to Electricity Conversion Efficiency} = \frac{55}{100} \times \frac{30}{100} \times \frac{95}{100} \times 0.893 \times 100$$

= 14%

Where:

Boiler Efficiency with sod peat at 40% moisture = 55%

Engine Efficiency = 30%

Generator Efficiency = 95%

Station Service Factor = 0.893

The Station Service Factor covers feedwater, condensate and cooling water pumping, fans, peat handling, blowdown and turbine hydraulic system.

Peat required to Generate 1 kWh = $\frac{3.6}{1.77}$ = 2.03 kg of peat

where:

- 1 kWh = 3.6 MJ

This factor must be further adjusted to compensate for 8% line and transformer losses within the distribution system.

Peat required to deliver 1 kWh to the consumer = 1.08 x 2.03
= 2.19 kg

The tonnes of peat required to satisfy the 20 Amp Service Scenario are summarized in Table No. 11 which follows:

TABLE NO. 11

20 AMP HOUSE SERVICE SCENARIO

Milestone Year	Annual Consumption (kWh) Houses (1)	Community Buildings (2)	Total (3)=(1)+(2)	Peat Energy Conversion Factor kg/kWh (4)	Annual Peat Requirements (kg) (5)=(3)x(4)	Annual Peat (Tonnes) (5)/1000
1985	444,000	135,628	579,628	2.19	1,269,385	1,269
1990	636,000	220,209	856,209	2.19	1,875,098	1,875
2000	864,000	287,031	1,151,031	2.19	2,520,758	2,521

Note: Refer to Section 4.5.2 for the Electrical Demand Summary

4.2.4 - 100 Amp Service Scenario

4.2.4.1 - Housing Electrical Projections

TABLE NO. 12

HOUSING ELECTRICAL PROJECTIONS

Milestone Year (1)	No. of Houses (2)	kw Demand per House (3)	Total kW Demand (4)=(2)x(3)	kWh of Consumption (5)	Total kwh of Consumption (6)=(2)x(5)
1985	74	6	444	10,000	740,000
1990	106	6	636	10,000	1,060,000
2000	144	6	864	10,000	1,440,000

4.2.4.2 Community Building Electrical Demand Projections

Community buildings would normally have 100 Amp service even if the houses only had 20 Amp service. Thus, the community building load projection in the 20 Amp Scenario, Section 4.2.3.2 would be applicable to this 100 Amp scenario.

4.2.4.3 Equivalent Peat Requirements

The tonnes of peat required to satisfy the 100 Amp Service Scenario are summarized in Table No. 13 on the next page.

TABLE NO.13

100 AMP HOUSE SERVICE SCENARIO

Milestone Year	Annual Consumption (kWh) Houses (1)	Community Buildings (2)	Total (3)=(1)+(2)	Peat Energy Conversion Factor kg/kWh (4)	Annual Peat Requirements (kg) (5)=(3)x(4)	Annual* Peat (Tonnes) (5)/1000
1985	740,000	135,628	875,628	2.19	1,917,625	1,918
1990	1,060,000	220,209	1,280,209	2.19	2,803,658	2,804
2000	1,440,000	287,031	1,727,031	2.19	3,782,198	3,782

Note: Refer to Section 4.5.4 for the Electrical Demand Summary

*Refer to Section 4.4(b) for the adjusted Annual Peat (Tonnes)

4.3 Space Heating

4.3.1 - Houses

The existing houses in the Cat Lake Indian Community were built to reasonably similar standards including 50 mm. x 100 mm (2" x 4") wall construction with R-12 insulation and vapor barrier, wood board and batten or plywood exterior and internal panelling. The ceilings usually have tiles and often there is insulation which was assumed to be R- 12. Floors are typically tile over plywood without insulation. The houses have two doors, a mix of glazing standards and considerable air infiltration. The house size has typically been 68 m^2.

New houses will have 50mm x 150 mm (2" x 6") wall construction to facilitate the use of R-20 insulation. The floors and ceiling will also have the R-20 batts of insulation. The future homes will be 25% larger, in the range of $85m^2$.

Appendix 'C', Housing Heat Loss Calculations, provides the analysis of the annual heat losses for the existing and future houses. The results are as follows:-

- Existing Houses - 117,838 MJ/year
- New Houses - 69,950 MJ/year

It is easier to relate heat losses to different forms of energy required to satisfy the calculated conditions. There would definitely be experience with wood in Cat Lake and it would be possible to relate oil consumption from the Teacherage. For this study heating with peat is pertinent and there is an element of at least supplemental electric heating so that these are also offered below for comparison purposes.

Wood

It is assumed that 80% will be black spruce and 20% white birch. Tree size will affect the density of wood in a cord. A cord is estimated to be 3,000 pounds based on the above mix and 30% moisture resulting from one season of air drying. Using 60% stove efficiency which assumes an air tight stove operating at the low end of normal capability (i.e. 60-70%), the usable heat from a cord of the mixed wood is 11,128 MJ. Using a Franklin type of stove operating at 40% which is the upper range of normal capability (i.e. 30-40%), the usable heat from a cord of mixed wood is 7,419 MJ. The equivalent wood requirements are summarized in the following table.

House Type	Annual Heat Loss (MJ)	High Efficiency Stove Annual Wood (Cords)	Franklin Stove Annual Wood (Cords)
Existing	117,838	10.6	15.9
New	69,950	6.3	9.4

Oil

Residential oil furnaces operate at 60 to 70% efficiency with the lower figure selected for comparison purposes. The heating value of No.2 Fuel Oil is 38.68 MJ/litre with the usable heat equal to 23.21 MJ/litre. The equivalent oil requirements can be summarized as follows:

House Type	Annual Heat Loss (MJ)	Annual Oil (litres)
Existing	117,838	5,077
New	69,950	3,014

Electricity

Electrical resistance heat within a house results in a 100% efficiency of energy transfer between kilowatt hours (kWh) and usable heat in megajoules (MJ). The conversion of 1 kWh = 3.6 MJ is applied to result in the following:-

House Type	Annual Heat Loss (MJ)	Electrical Consumption (kWh)
Existing	117,838	32,733
New	69,950	19,431

Peat

The peat consumption requirements are shown for the two classes of stove used for the wood burning example. Based on the Cat Lake bore hole data the average peat heating value at 40% moisture content is 5,450 Btu/lb, and 12,672 MJ/tonne. Based on previously used stove efficiencies the usable heat per tonne is 5,068 MJ and 7,603 MJ for the Franklin and High Efficiency types respectively. The comparative energy usage numbers are as follows:-

House Type	Annual Heat Loss (MJ)	High Efficiency Stove Annual Peat (Tonnes)	Franklin Stove Annual Peat (Tonnes)
Existing	117,838	15.5	23.2
New	69,950	9.2	13.8

Appendix 'B', Housing Projections, provides a breakdown of the number of existing and new houses for the milestone years of 1985, 1990 and 2000. A reasonable basis for projecting housing peat consumption would be to assume that all existing houses are equipped with Franklin Type stoves operating at 40% efficiency and future homes have high efficiency stoves operating at 60% efficiency. The annual peat requirements for the milestone years are as follows:

Year	Total	Houses Existing	New	Annual Peat Per House (Tonnes)	Annual Peat Sub-Totals (Tonnes)	Total Annual Peat (Tonnes)
1985	74					
		74		23.2	1,717	
			-			1,717
1990	106					
		54		23.2	1,253	
			52	9.2	478	1,731
2000	144					
		21		23.2	487	
			123	9.2	1,132	1619

4.3.2 - Community Buildings

The school has the best insulation standards of all existing community buildings and would represent a reasonable projection of average future building construction. The construction includes 4" (R-14) insulation in the walls to ground level and 6" (R-20) in the ceilings.

Other existing buildings have been constructed to lower standards of insulation. Appendix 'D', Community Building Heat Loss Calculations provides the analysis for new community building annual heat losses to be applied for the study Milestone Years using the school as the model. The heat loss assignments for projected future buildings in accordance with the school standards should be reasonable. The heat loss for the existing buildings has been estimated to be the same as existing houses per the Case I detailed calculation in Appendix 'C', Housing Heat Loss Calculations. This is somewhat arbitrary, but the order of magnitude appears to be reasonable. The unit heat loss factors, which are applied to the buildings are as follows:

. Existing Community Buildings excluding the school	1,733	MJ/m^2/year
. Future Community Buildings and the school	919	MJ/m^2/year

The community building peat requirements have been projected on the basis of 60% efficient stoves and furnaces which means that 7,603 MJ of usable heat are realized per tonne of peat.

The Community Building heating requirements for the year 1985 are projected to be as follows:

TABLE 14

COMMUNITY BUILDING HEATING REQUIREMENTS

Building Description	Size (m^2)	Annual Heat Losses (MJ)	Annual Peat Required (Tonnes)
School with Clinic	696	639,624	84.1
Teacherage (3)	251	434,983	57.2
Diesel Shed	56	97,048	12.8
School Pump House	20	34,660	4.6
Warehouse/Agency Cabin	116	201,028	26.4
Band Office	113	195,829	25.8
Recreation Hall(Community)	223	386,459	50.8
Repair Shop	37	64,121	8.4
2 Churches	251	434,983	57.3
2 Stores	279	483,507	63.6
Radio Station	37	64,121	8.4
Health Centre (NHW)*	46		
Pool Hall	37	64,121	8.4
ANNUAL PEAT REQUIRED AS OF 1985 FOR COMMUNITY BUILDING HEATING			407.8 Tonnes

The annual peat requirements have all been calculated on the basis of the average annual heat losses in MJ/year for the Community Buildings as detailed in Section 4.3.2. This note also applies to the 1990 and 2000 Community Buildings heating requirements projection tables which follow.

* It has been assumed that the National Health and Welfare Health Centre will continue to be heated by oil.

The Community Building heating requirements for the year 1990 are projected to be as follows:

TABLE NO. 15

COMMUNITY BUILDING HEATING REQUIREMENTS 1990

Building Description	**Size (m^2)**	**Annual Heat Losses (MJ)**	**Annual Peat Required (Tonnes)**
1985 TOTAL PER PREVIOUS TABLE		-	407.8
Airport Building	56	51,464	6.8
Water Supply	56	51,464	6.8
Child Care Centre	93	85,467	11.2
Medical Clinic/ Nursing Station	100	91,900	12.1
Senior Citizens Complex (8 units)	200	183,800	24.2
Laundromat	50	45,950	6.0
Fire Hall (Truck Bay and Training Room)	100	91,900	12.1
Hockey/Skating Rink	-		
Indoor Gymnasium	600	551,400	72.5
Works Yard/3 Bay Maintenance Garage	150	137,850	18.1
Fuel Depot(Bulk Tank Surrounded by Chain Link Fence)	-		

ANNUAL PEAT REQUIRED AS OF YEAR 1990 FOR COMMUNITY BUILDING HEATING — 577.6 Tonnes

The Community Building heating requirements for the year 2000 are projected to be as follows:

TABLE 16

COMMUNITY BUILDING HEATING REQUIREMENTS - 2000

Building Description	Size (m^2)	Annual Heat Losses (MJ)	Annual Peat Required (Tonnes)
1990 TOTAL PER PREVIOUS TABLE		-	577.6
Drop-In Centre	130	119,470	15.7
Coffee Shop	70	64,330	8.5
Band Co-Operative Store c/w two warehouses	410	376,790	49.6
Bakery	75	68,925	9.1
Motel (Equivalent to 3 B.R. House)	100	91,900	12.1
Police Station	85	78,115	10.3
Craft Centre	160	147,040	19.3
Bingo/Film Hall	80	73,520	9.7
ANNUAL PEAT REQUIRED AS OF YEAR 2000 FOR COMMUNITY BUILDING HEATING			711.9 Tonnes

4.3.3 Space Heating Demand Summary

The housing and community building space heating projections in Sections 4.3.1 and .2 respectively can be combined to represent community totals as follows:

TABLE NO. 17

YEAR	**ANNUAL PEAT REQUIREMENTS (Tonnes)**		
	Houses (1)	**Community Buildings (2)**	**Totals (5)=(1)+(2)**
1985	1,717	408	2,125
1990	1,731	578	2,309
2000	1,619	712	2,331

4.4 Peat Demand Summary, 1985, 1990, & 2000

The projected peat demand volumes for the Milestone Years of 1985, 1990 and 2000 have been determined for electrification in Sections 4.2.3.3 and 4.2.4.3 for 20 Amp and 100 Amp services respectively and for space heating in Section 4.3.3. The Peat Energy Conversion Centre has been excluded from the energy summaries so far since, in the case of electrical projections in particular, the data would also be used for the Diesel Generator option. The heat given off from the peat conversion operation including the heat from the flue gases will support the space heating requirements within the Peat Energy Conversion Centre and the associated storage enclosures.

A greenhouse has not been identified in the draft Marshall Macklin Monaghan planning report. However, we believe that a greenhouse should be considered as an added benefit of the peat utilization concept. Regardless of the closed system heat balances for the gasifier/diesel generator or boiler/steam engine/generator options the facilities would be available to create heat in usable form for a greenhouse operation. The peat requirements which follow include allowances to support a 300 m^2 energy efficient greenhouse.

The total peat requirements can be summarized as follows:

a) Annual Peat Requirements (Tonnes)
20 Amp Service Plus Space Heating

Milestone Year	20 Amp Electrification	Space Heating	Greenhouse	Total Tonnes
1985	1,269	2,125	-	3,394
1990	1,875	2,309	111	4,295
2000	2,521	2,331	111	4,963

b) Annual Peat Requirements (Tonnes)
100 Amp Service Plus Space Heating

Milestone Year	100 Amp Electrification	Space Heating	Greenhouse	Total Tonnes
1985	1,918	2,125	-	4,043
1990	2,804	2,309	111	5,224
2000	3,782	2,331	111	6,224

If 100 Amp electrical service could be supplied at reasonable cost because of the local peat resource it is likely that some electricity would be used for supplementary house heating. The 100 Amp service, used exclusively for heating, would only satisfy approximately 80% of the peak heating load for the existing houses with a design average room temperature of 64° F. The new houses could be totally satisfied with the same limiting assumptions. The point to be made is that there would be a desire to supplement the space heating in the rooms furthest from the central stove in particular and that the 100 Amp electrical supply has some capacity to satisfy this desire. The space heating peat requirements have not been reduced under this assumption.

The currently used energy conversion factors are as follows:

Peat burned in a residential stove for heating (Average of 60% and 40%)	50%
Peat Energy Converted to Electricity For Heating	14%
Difference	36%
Peat losses in the handling of the fuel between the central storage and the residential stove, say	(6%)
Net Peat Energy Utilization Difference	30%

Assuming that 25% of the residential heating load was provided by electricity in lieu of sod peat burning the total community annual tonnes of peat required would be increased by 59% (Refer to Appendix E) to accomodate the phenomena of some electrical heating being substituted for space heating with the 100 Amp supply scenario. Alternatively, it might be argued that the electric heat would be supplementary to the peat fired space heating rather than a substitution. However, the calculated 'substitution' quantities might also reasonably serve as the 'supplementary' quantities. The annual peat requirements with 100 Amp electrical service might then be modified as follows:

TABLE NO. 18

ANNUAL PEAT REQUIREMENTS - 100 AMP ELECTRICAL SERVICE

Milestone Year	**Previously Calculated Annual Peat Totals For 100 Amp Electrification (Tonnes)** (1)	**Electrical Substitution or Supplementary Heating Peat Requirements** (Tonnes) (2)=0.59 x (1)	**Total Projected Annual Peat Requirements For 100 Amp Electrification** (Tonnes) (3)=(1)+(2)
1985	1,918	1,132	3,050
1990	2,804	1,654	4,458
2000	3,782	2,231	6,013

The total annual peat requirements for the modified 100 Amp Scenario could then be summarized as follows:

TABLE NO. 19

TOTAL PEAT REQUIREMENTS

SPACE HEATING & MODIFIED 100 AMP ELECTRICAL SERVICE

Milestone Year	Modified 100 Amp Electrification Per Previous Table	Space Heating	Greenhouse	Total Tonnes
1985	3,050	2,125	-	5,175
1990	4,458	2,309	111	6,878
2000	6,013	2,331	111	8,455

The annual peat requirements for the 20 Amp and 100 Amp Scenario for the Milestone Years are illustrated on the graph on the following page.

CAT LAKE INDIAN RESERVE

PEAT REQUIREMENTS

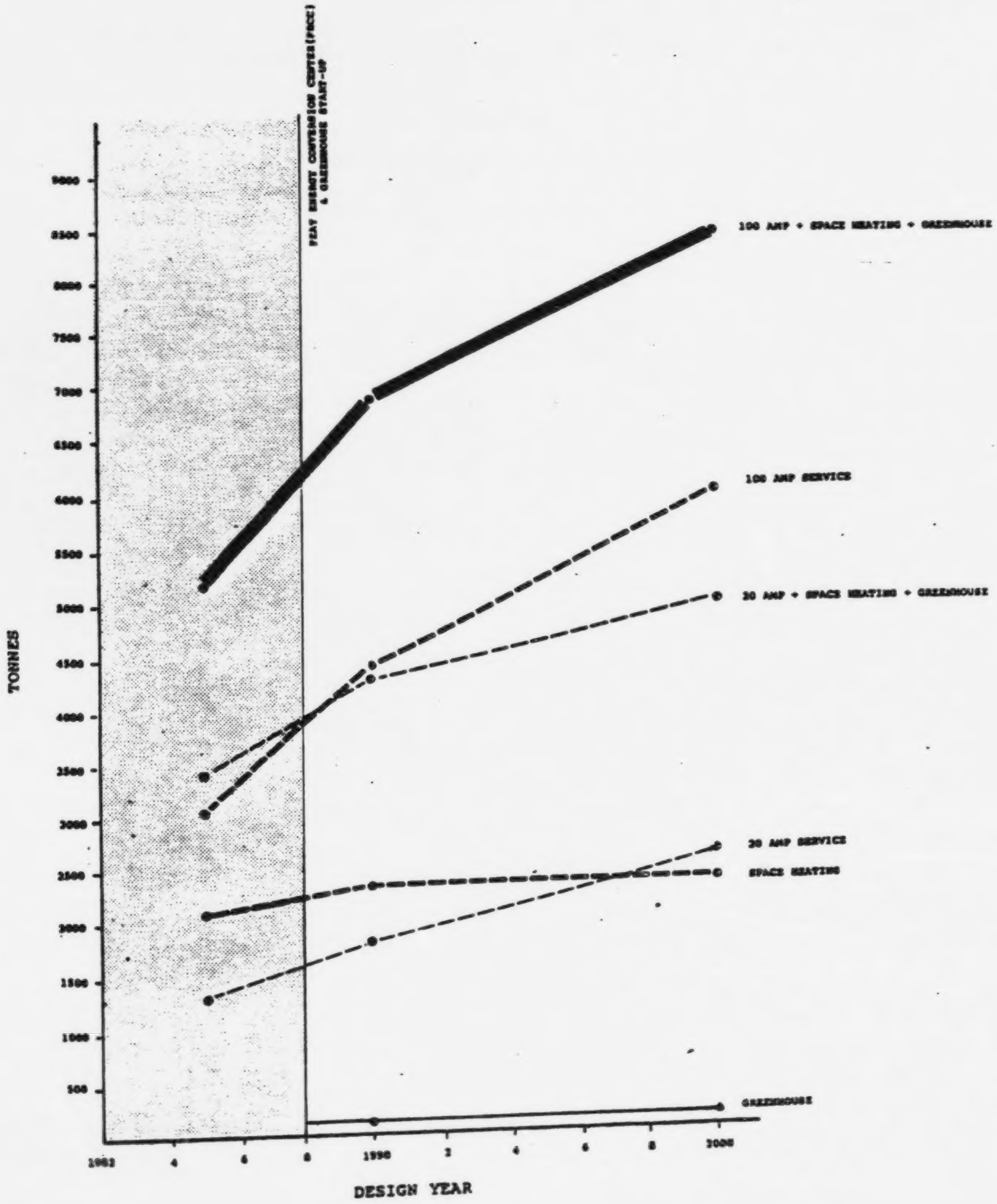


FIGURE 2 .

4.5 Electrical Summary 1985, 1990 and 2000

4.5.1 20 Amp Consumption

From Section 4.2.3.3 the electrical consumption for the 20 Amp Scenario can be summarized as follows:

Milestone Year	Annual Consumption (kWh)
1985	579,628
1990	856,209
2000	1,151,031

4.5.2 20 Amp Demand

The electrical demand for houses and community buildings was established in Sections 4.2.3.1 and 4.2.3.2 respectively. The electrical demand for the Peat Energy Conversion Centre and the Greenhouse was estimated as part of the preliminary design. The electrical demand for the 20 Amp Service Scenario follows:

TABLE NO. 20

ELECTRICAL DEMAND
20 Amp House Service Scenario

Milestone Year	Demand (kW) Houses (1)	Demand (kW) Community Buildings (2)	Total Demand For Diesel Option (kW) (3)=(1)+(2)	Peat Energy Conversion Centre & Greenhouse Demand (kW) (4)	Total Demand (kW) For Peat Generation Options (5)=(3)+(4)
1985	88.8	40.58	129.4	-	129.4
1990	127.2	65.87	193.1	24	217.1
2000	172.8	85.85	258.7	28	286.7

4.5.3 100 Amp Consumption

Section 4.2.4.3 provided the initial electrical consumption summary. Section 4.4(b) developed the concept that, with 100 Amp service, some electricity would be used to supplement house space heating. The calculated "extra peat" for supplementary electric heating can be converted to equivalent kWh using the factor of 2.19 kg of peat required to deliver 1 kWh that was developed in Section 4.2.33 (457 kWh/tonne of peat). The 100 Amp Scenario electrical consumption is summarized below:

Milestone Year	Total Consumption per 4.2.4.3 (kWh) (1)	Annual Peat For Supplementary Electric Heating per 4.4(b) (tonnes) (2)	Tonnes Peat to kWh Conversion Factor (3)	Electrical Heating (kWh) (4)=(2)x(3)	Annual Consumption (kWh) (5)=(1)+(4)
1985	875,628	1,132	457	517,324	1,392,952
1990	1,280,209	1,654	457	755,878	2,036,087
2000	1,727,031	2,231	457	1,019,567	2,746,598

4.5.4 100 Amp Demand

The initial electrical demand for houses and community buildings was identified in Sections 4.2.4.1 and 4.2.4.2 prior to the development of the concept that some electricity would be used for supplementary heating. We have assumed that the heating demand would be spread over six months with a supplementary electrical heating diversity factor of 67%. Using the newly developed kWh annual consumption data, the supplementary heating demand can then be calculated. The Peat Energy Conversion Centre and Greenhouse demands were calculated separately as part of the preliminary design. The table, which follows, summarizes the electrical demand for the 100 Amp Scenario.

TABLE 21

ELECTRICAL DEMAND
Modified 100 Amp House Service Scenario

Milestone Year	Demand (kW)		Supplementary Electrical House Heating (kW)	Peat Energy Conversion Centre & Greenhouse Demand (kW)	Total Demand (kW)
	Houses (1)	Community Buildings (2)	(3)	(4)	
1985	444	40.58	176	-	661
1990	636	65.87	258	38	998
2000	864	85.85	347	48	1,345

5.0 Evaluation of Resource Base and Conceptual Planning

5.1 General

The North American peat industry is currently undergoing rapid growth and diversification; commercial horticultural operations are increasing in number and size, particularly in eastern Canada; research studies concerning the undrained peatlands are on-going; and, several small-scale energy peat mining and processing operations are in the planning or pilot test stages.

5.2 Selected Peatlands

The evaluation of the Resource Base was limited to three pre-selected areas. These areas are designated as Area I, II and III and their locations in relation to the Cat Lake Indian Community are shown on Drawing No. 2. The three areas were selected from existing mapping produced by the Department of Energy, Mines and Resources, Ottawa (1976) and from aerial photographs produced by the Ministry of Natural Resources (1976) and the Ministry of Transportation and Communications (1983).

Local identification of the targeted peat lands was carried out by recognizable landmarks from aerial photographs and with the assistance of residents of the Community.

Sampling was carried out by means of the Mini-MacCauley Sampler (5 cm diameter by 50 cm long). Representative samples were brought to our laboratory for detailed physical and chemical analyses, for details see the Progress Report - Part 1.

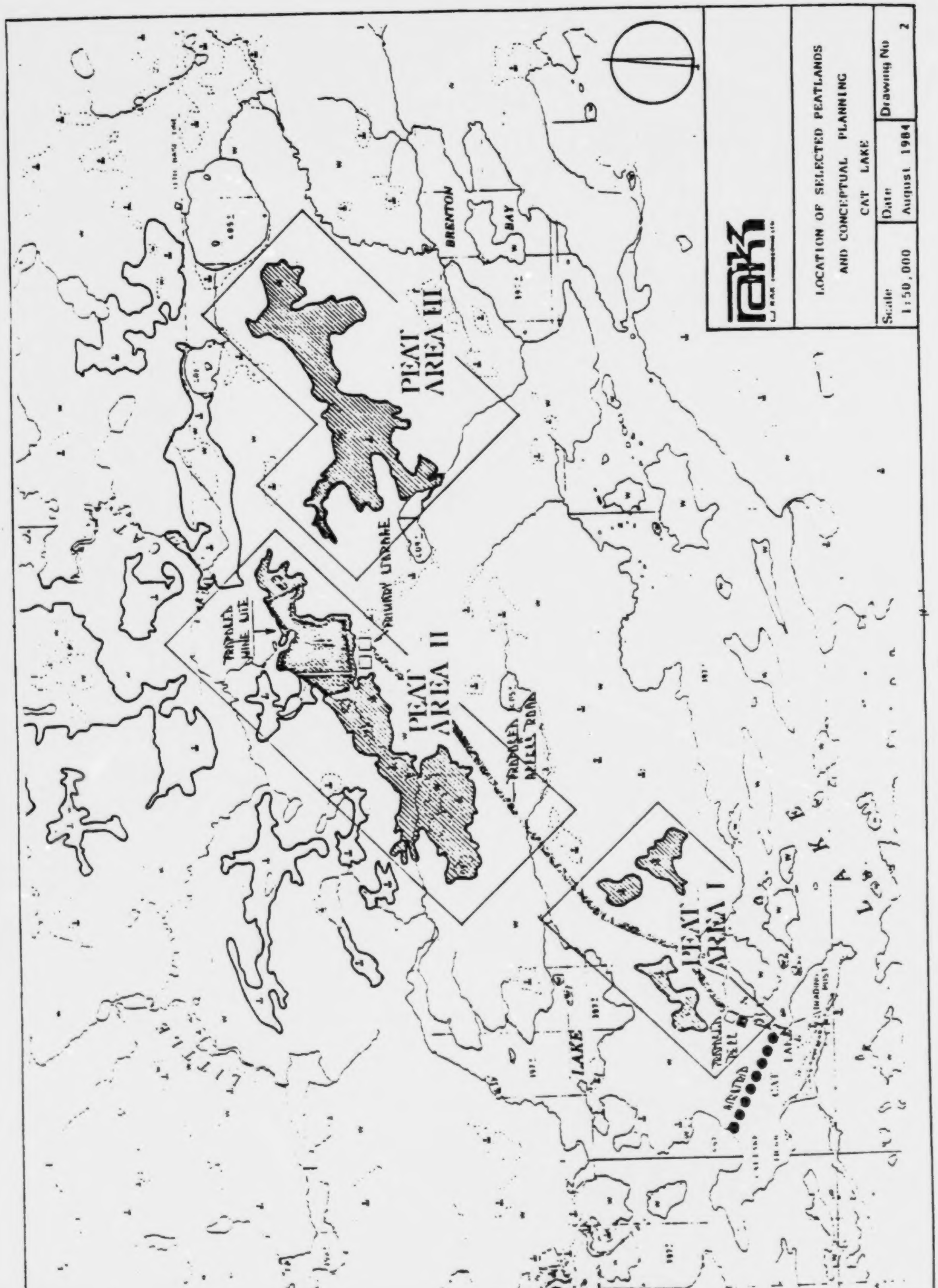
5.3 Quality and Quantity of Targeted Peat Reserves

The quality of the investigated peat reserves, in terms of fuel potential, varies from the Von Post (degree or humification) value of H-4 to H-7. The interpolated calorific values of 5000 to 5500 Kcal/kg correlate well with the tested values of 4908 to 5287 Kcal/kg shown in Table 3; and are believed to be representative of the investigated peat deposits.

The preliminary estimate of the available resource base in the three suggested mine areas is summarized in Table 4. The total estimated quantities of between 970,000 and 1,880,000 tonnes represent the available ready-to-burn peat fuel at 50% moisture content.

The accepted conversion is of 1 tonne of peat at 50% moisture content being equal to 2.5 MWh. The last reported electricity consumption at Cat Lake (EMR 1980) is in the order of 500 MWh per annum. Based on the above conversion factor, and maintaining the same level of service, this would require an annual production of only 800 tonnes of peat fuel at 24% efficiency.

Based on the population trends and corresponding energy requirements described in Sections 3 and 4 of this report, the available peat fuel reserves appear more than adequate.


LOCATION OF SELECTED PEATLANDS
AND CONCEPTUAL PLANNING
CAT LAKE
Scale
1:50,000
Date
August 1984
Drawing No
2
PEAT AREA I
PEAT AREA II
PEAT AREA III
BRENTON
BAY
PRIMARY LINKAGE
LITTLE
LAKE
CAT LAKE
AIRSTRIP

	A-II BH 3/S2		A-II BH 4/S2		A-III BH 1/S4		A-III BH 4/S3	
	As Rec'd.	Dry Basis	As Rec'd.	Dry Basis	As Rec'd.	Dry Basis	As Rec'd.	Dry Basis
Moisture, w.t.%	91.0	-	89.7	-	90.1	-	90.1	-
Bulk Density: lbs./ft.^{3}	62.7	19.2	64.6	21.2	64.3	21.1	63.6	21.3
kg/m^3	1004	307	1035	339	1030	337	1019	342
pH	5.25		5.65		5.40		5.60	
Phosphorus (P), wt.%	0.003	0.030	0.004	0.042	0.004	0.037	0.003	0.035
Calorific Value, BTU/lb.	854	9510	911	8827	891	8992	888	9002
Kcal/kg	475	5287	506	4908	495	4999	494	5005
Ultimate Analysis								
Moisture, %	91.02	-	89.68	-	90.09	-	90.13	-
Carbon (C), %	4.76	52.96	5.00	48.45	5.24	52.89	5.21	52.79
Hydrogen (H), %	0.49	5.50	0.54	5.25	0.55	5.55	0.53	5.37
Nitrogen (N), %	0.18	1.98	0.24	2.28	0.19	1.92	0.20	2.04
Sulphur (S), %	0.02	0.20	0.04	0.39	0.02	0.21	0.02	0.21
Ash, %	0.51	5.71	1.38	13.37	0.84	8.45	0.81	8.25
Oxygen by Difference, %	3.02	33.65	3.66	30.26	3.04	30.99	3.10	31.34

QUALITATIVE ANALYSIS OF PEAT
TABLE NO. 22

PEAT AREA	DRAWING NUMBER	SUGGESTED MINE AREA IN m²	ESTIMATED RESOURCE BASE IN TONNES*, WITH RECOVERABLE DEPTH OF PEAT OF:		
			1.00 m	1.5 m	2.00 m
IA	3	82,500	28,800	N/A	N/A
IC	3	87,500	30,600	45,900	61,200
II	9	1,327,500	464,000	696,000	928,000
III	15	1,271,250	444,500	666,700	889,000
		TOTAL:	969,900	1,408,600	1,878,200

* NOTE: 1 TONNE = 2.86 m³ @ 50% MOISUTRE

ESTIMATED RESOURCE BASE
TABLE NO. 23

5.4 Conceptual Engineering and Production Planning

Commonly, peat mining is carried out by the milled peat, sod cutting, and hydraulic or wet peat production methods.

Due to the relatively small peat quantity requirements involved in this report, only the milled peat and sod cutting methods will be analysed. These two methods are considered more economical because of the limited equipment and labour requirements.

5.4.1 Site Preparation

In case of dry mining methods (milled and sod cutting), the most important feature in mine planning is the drainage plan.

The first step is to cut properly designed perimeter ditches, in order to drain off existing ponds, to isolate the bog from the surrounding terrain and to accelerate the drainage rate of surface runoff and spring melt waters during the pre-production stage.

Perimeter ditching should be completed in the first year of bog development and, as ditches tend to close up, at least two cuts over the same ditch are recommended during the pre-production phase. Cross-bog ditches, up to 400 meters apart, should also be developed during the early pre-production stage. To achieve maximum gravitational drainage, they should be planned at 45° to the main drainage pattern. Commonly used ditch cutting equipment is capable of excavating V-shaped trenches, up to 2 meters wide and 2 meters deep, at a rate of about 100 meters per hour.

The second step involves the removal of trees, shrubs and live moss from the bog. Any buried stumps must be removed and the fields must be graded and ditched to provide additional drainage. The fields between ditches are usually profiled to a 20:1 slope, to accelerate surface runoff. Field ditches, spaced between 10 and 50 meters, are usually 1 meter wide and 1 meter deep. To maintain efficient drainage, each ditch should be re-cut once a year or as required.

5.4.2 Milled Peat Method

Milled peat mining is based on air-drying of a fine surface layer of peat to approximately 50% moisture content.

The first operation in the production cycle is the milling of the surface layer to depths of 10 to 15 millimeters. The milled peat layer is left on the surface of the field for air-drying. When the moisture content is reduced to about 65% (one day of good drying) the layer is turned over by a spoon harrow to expose its underside. This operation may have to be repeated over two or three days, in order to lower the moisture content to 45% - 50%. Extra harrowing may be required if rain interupts the drying process.

As soon as the moisture content drops to the desired value, the milled peat layer is harvested by pneumatic or vacuum harvesters. The dry layer is vacuumed into the hopper tank while the harvester is moving. The vacuuming power as well as the driving speed can be adjusted, making pneumatic harvesting flexible to accommodate changing weather conditions.

The harvester empties its load next to the bog, where the milled peat is compacted by a crawler tractor to a 4-5 meter high stockpile. If not properly compacted, the temperature and moisture content of the peat will increase due to an oxidation process caused by micro-organisms. The increased activity raises the temperature up to 80°C in a few weeks and spontaneous combustion may occur. In order to prevent fire and loss of quality in stockpiles, the milled peat should be tightly compacted.

5.4.3 Sod Cutting Method

The sod peat production method is based on air-drying "sods" of peat which have been cut from the bog and mechanically extruded onto the field to dry.

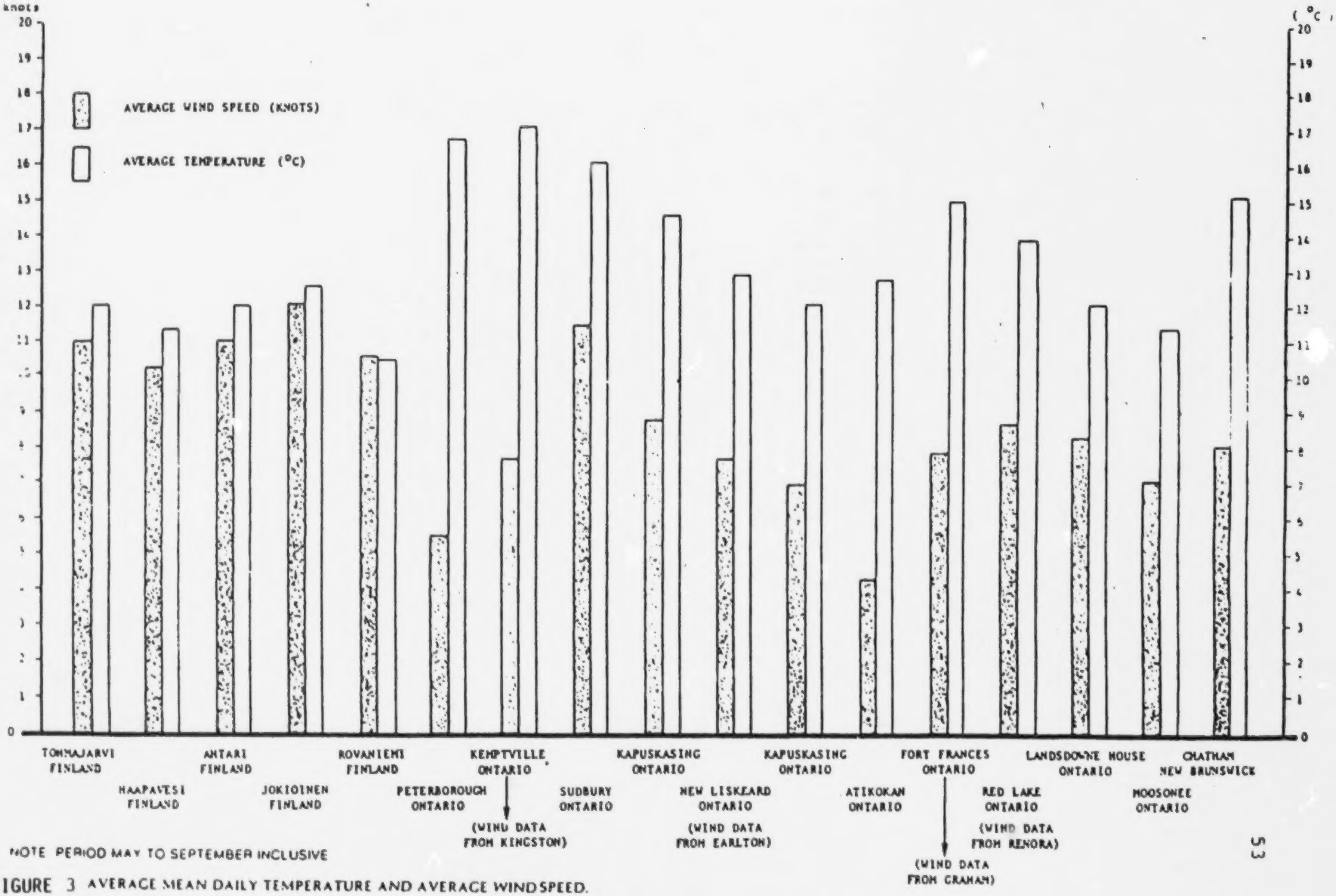
As soon as the sods are dry enough to resist moving without breaking (one week), they are turned over, by a sod turning machine, to cut the capillary connection with the field. When moisture content of the sods drops to about 35% (2 weeks), the sods are ridged by a linear ridger, loaded to bog trailers by a ridge loader and transported to the stockpile. At the end of the season, to weather protect the harvested peat, the stockpiles are covered with plastic. Usually, sod peat harvesting is safer then milled peat harvesting: a light rain does not moisten the sods inside, whereas the milled layer gets easily back to the original moisture content. On the summer, when it's possible to to produce small quantities of milled peat during sunny breaks. Sod peat, if properly screened, presents no problem with respect to self heating.

The equipment described in the above is, together with estimated costs further identified in Table 5.

5.4.4 Climatic Conditions

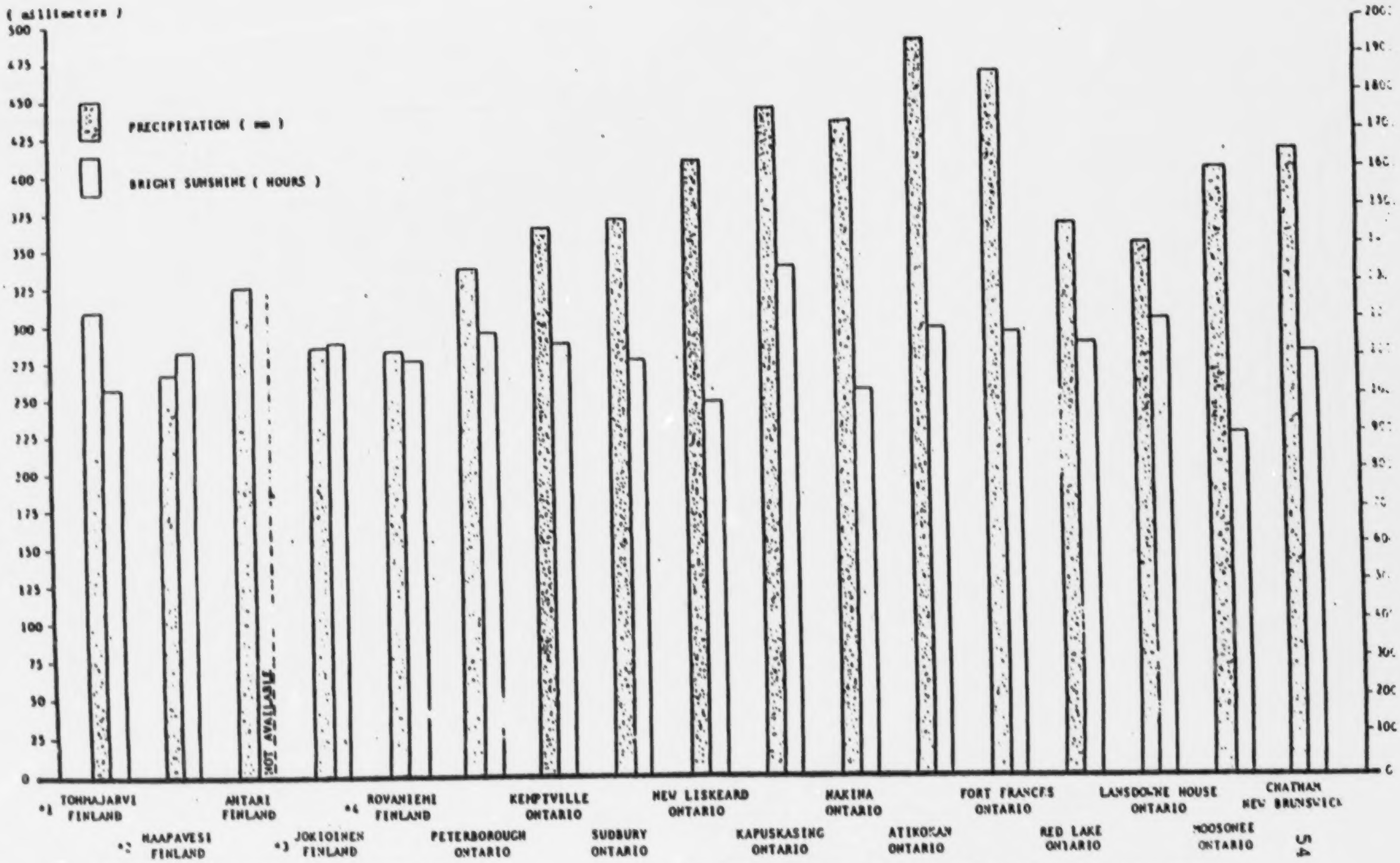
Specific climatic data for the community of Cat Lake are not available, but is believed to be similar to that of Red Lake, which lies only 80 kilometers to the west. The weather conditions at Red Lake, in turn, are similar to those of Sudbury for which extensive monitoring was done over the years (Figures 2, 3 and 4). Although rainfall rate in western Ontario is higher than in the rest of the province, between May and September, Red Lake shows less precipitation during the same period.

The mean wind speed for Red Lake, between May and September, is of the order of 15 knots or 27 km/h (Figure 3), condition helpful to the evaporation process. Assuming that weather conditions for Cat Lake are similar to those of Red Lake, the production of either milled peat or sod peat, June to August, is equally feasible from the climatic point of view.



NOTE PERIOD MAY TO SEPTEMBER INCLUSIVE

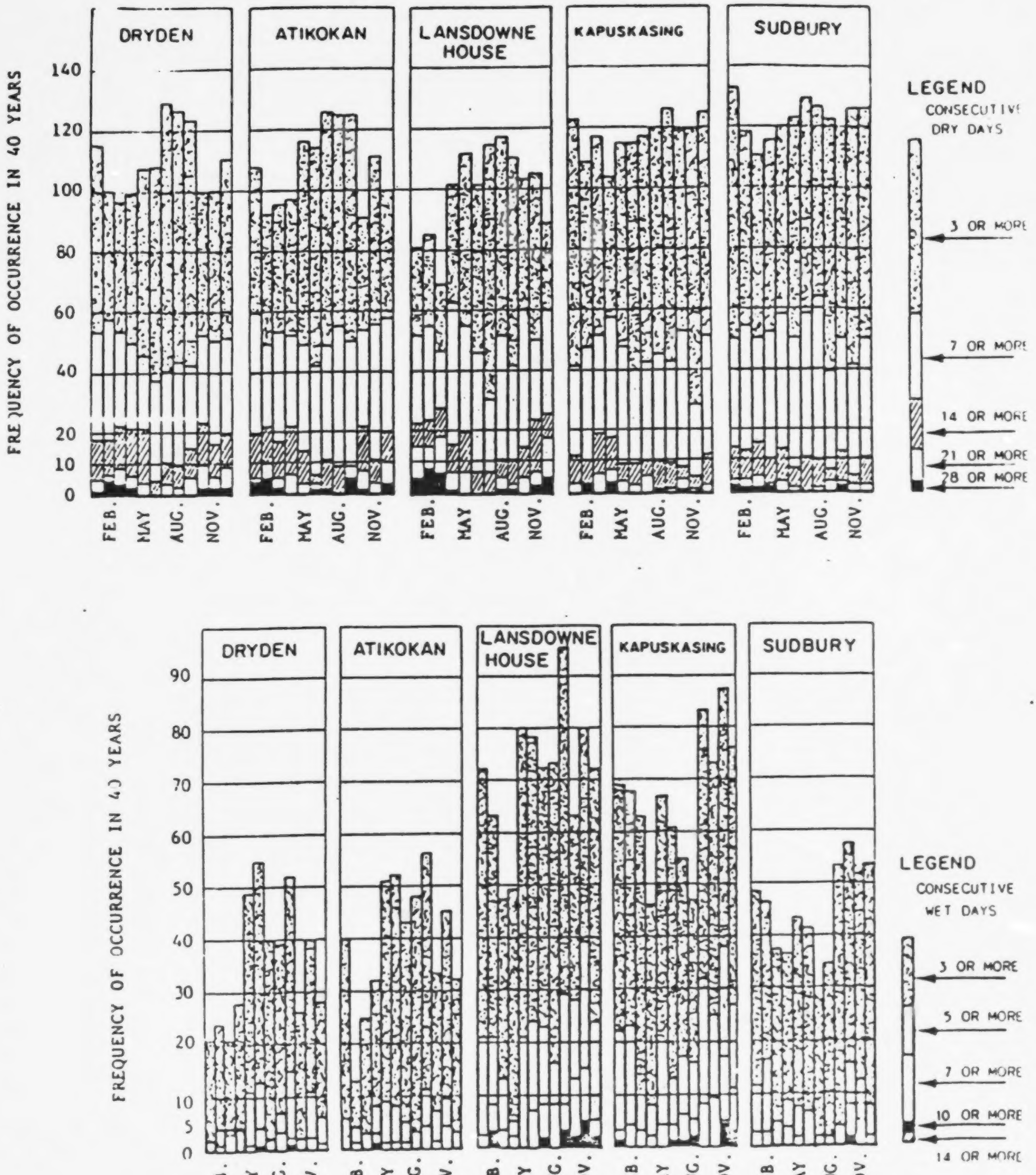
FIGURE 3 AVERAGE MEAN DAILY TEMPERATURE AND AVERAGE WINDSPEED.



PRECIPITATION AND BRIGHT SUNSHINE HOURS.

FIGURE 4

*FOR BRIGHT SUNSHINE HOURS, NEARBY ALTERNATIVE STATIONS WERE SELECTED
NOTE: PERIOD MAY TO SEPTEMBER INCLUSIVE



FREQUENCY OF OCCURENCE OF DRY AND WET DAYS
FIGURE 5

In summary, annual peat production rates for western Ontario are 170 and 110 tonnes per hectare for milled and sod peat respectively. If the milled peat method were to be chosen, at a yearly rate of 150 tonnes per hectare, only 70 hectares of bog need to be developed for a 10,000 tonne production at 50% moisture content. Assuming that the annual yield of sod peat will be around 100 tonnes per hectare, approximately 100 hectares of bog area have to be developed achieve a similar production at 30% moisture.

5.5 Estimated Costs

5.5.1 Capital Cost Estimate

The following capital cost estimate is based on the peat mine located in Area II and the following assumptions:

- Equipment and granular material required for the access road construction will be available on site (i.e. the MTC equipment used for the airport construction will be utilized).
- The total area of the proposed peat mine would initially be in the order of 30 Ha with an estimated resource base of about 150,000 tonnes of peat at 50% moisture content.
- The required peat mine equipment (site preparation and harvesting) will be brought in over a winter road by the Band.
- Labour and equipment operators will be provided by the Band and would participate in the training program carried out in Phase II - System Development. Management, tradesmen and other specialty support personnel will have to be brought in from outside.
- Road construction and peat mine site preparation will start in 1985 and peat feedstock will be available for the plant start up the first of 1988.

Description		**Budget**
Road Construction		$ 480,000
Peat Mine Site Preparation		110,000
Harvesting Equipment		350,000
Fire Equipment		15,000
	Total	$ 955,000

For details of the equipment see the following Table.

5.5.2 Operating Estimate

The following estimates are based on the average sod peat harvesting costs in Finland converted to Cat Lake environment. This results in the total cost for:

- Milling/Sod Extraction
- Harrowing
- Loading
- Transportation; and
- Stockpiling at the Bog

OPERATION	EQUIPMENT REQUIRED	No	ESTIMATED UNIT PRICE $	ESTIMATED TOTAL PRICE $
SITE PREPARATION	4-WD TRACTOR	1	30,000	30,000
	DITCHER	1	15,000	15,000
	SCREW LEVELLER (PROFILER)	1	28,000	28,000
	GRADER	1	11,000	11,000
			TOTAL	84,000
SOD PEAT	4-WD TRACTOR	2	30,000	60,000
	SOD EXTRUDER	3	18,500	55,500
	SOD HARROWER	2	11,500	23,000
	SOD RIDGER	1	11,000	11,000
	SHAKER SCREEN	1	25,000	25,000
	RIDGE LOADER	1	37,700	37,700
	BOG TRAILER	2	13,000	26,000
			TOTAL	238,200
MILLED PEAT PLANT @ BOG	4-WD TRACTOR	2	30,000	60,000
	MILLER	1	8,000	8,000
	HARROWER	2	3,500	7,000
	VACUUM	3	18,000	54,000
			TOTAL	129,000
MILLED PEAT PLANT @ CAT LAKE	LOADER	1	50,000	50,000
	TRAILLERS	2	13,000	26,000
	2-WD TRACTORS	2	18,000	36,000
	SAME AS PLANT @ BOG	-	-	129,000
			TOTAL	241,000

NOTE: ABOVE PRICES DO NOT INCLUDE DELIVERY CHARGES TO CAT LAKE.

ESTIMATED EQUIPMENT COST
TABLE 24

in the order of $ 6 to $ 8 per tonne.

Estimates of the harvesting costs during the milestone years could then be summarized as follows:

Milestone Yeat	Total Tonnes	Unit Cost ($/tonne)	Total Cost ($)
1985	5175	8*	41,400
1990	6878	7	48,146
2000	8455	6	50,730

* It is expected that the unit cost will in fact decrease with increase in harvested volume.

The corresponding annual personnel and maintenance estimates are summarized following:

Item	Time	Unit Cost	Total Annual Cost
1 Manager	4 Months	2000	$ 8,000
1 Foreman	4 Months	1500	6,000
2 Workers	4 Months	1500	12,000
Spare Parts			5,000
Miscellaneous			3,000
		TOTAL	$ 34,000

The estimated transportation cost between the stockpile (at bog) and the storage area (at plant) are based on $ 0.20/tonne/km x 20 km = $ 4.0/tonne delivered to P.E.C.C.

Total Operating Costs

The total operating costs and the operating costs per tonne are summarized in the following Table:

TABLE 25

Summary of Operating Costs

Milestone Year	**Total Tonnes**		**Unit Costs**		**Total**	
		Harvesting	**Personnel**	**Transport**	**Per Tonne**	**Total**
1985	5175	8	6.50	4	18.50	95,737
1990	6878	7	4.90	4	15.90	109,360
2000	8455	6	4.00	4	14.00	118,370

5.5.3 Delivered Peat Cost

The estimated cost of peat sod feedstock delivered to the storage yard at the P.E.C.C. is summarized following:

Milestone Yeat	**Total Tonnes**	**Total Capital Cost***	**Total Operating Cost**	**Cost Per Tonne**
1985	5175	63,666	95,737	30.80
1990	6878	63,666	109,360	25.15
2000	8455	63,666	118,370	21.53

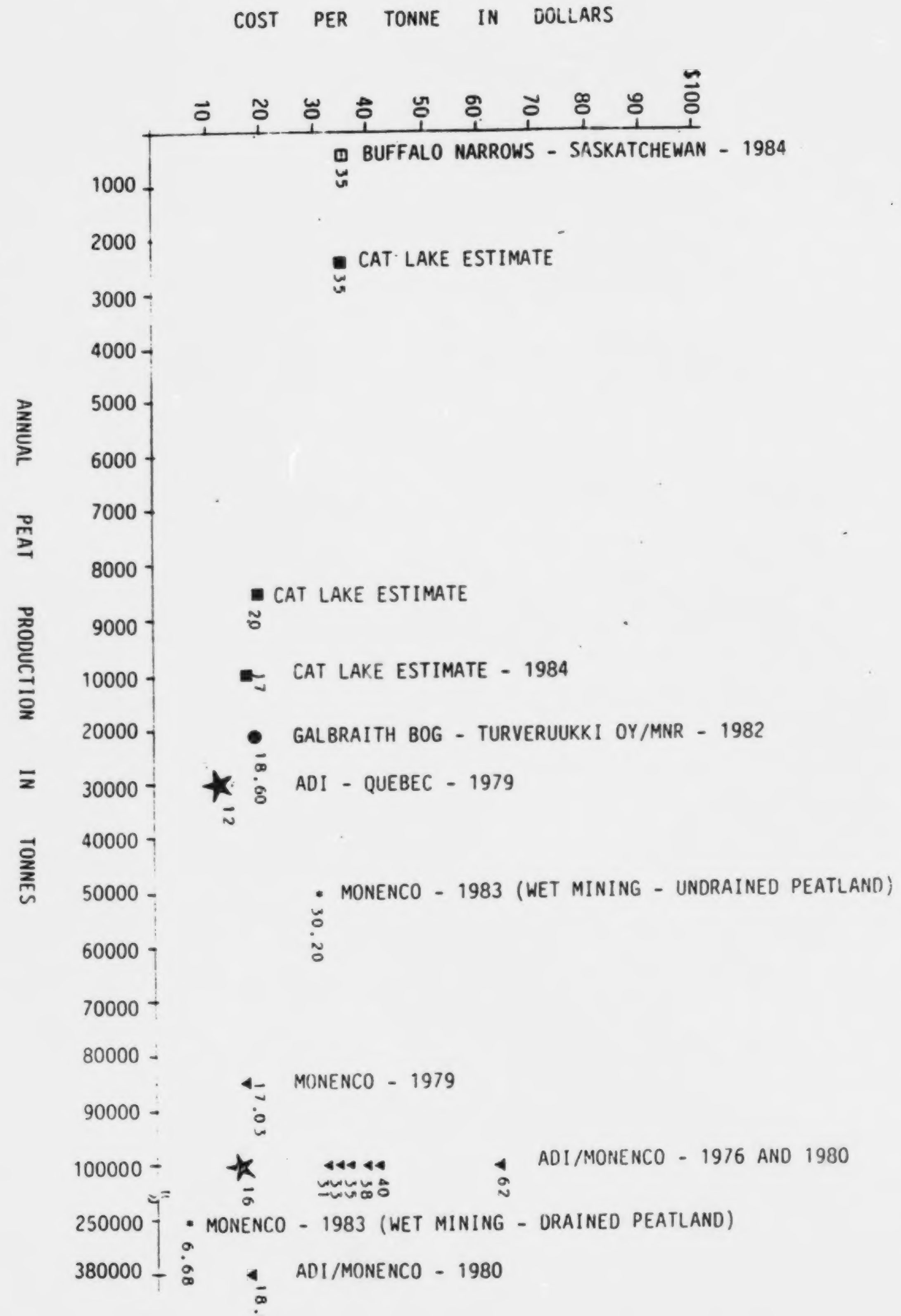
The total capital investment as per Section 5.5.1 of 955,000 amortized over 15% with no interest rate applied = $ 63,666.

Summary

The preliminary cost estimates of the delivered peat sod have been, as shown in the following Figure, compared to cost figures developed by others.

It is interesting to note that while all sources listed agree that the cost per tonne of delivered peat would decrease with the increased annual production; the trend shown in the following Figure does not support such rationale.

For the purpose of this study the actual peat cost at the Buffalo Narrows project, Saskatchewan ($ 35.00/tonne) has been adopted for the year 1985 production rate and a projected $ 20.00/tonne for the year 2000 production rate.



COMPARISON COSTS OF DELIVERED PEAT
FIGURE 6

6.0 Selection of System Alternatives
6.1 General

The existing source of electrical power in the Cat Lake Community are diesel and gas generators.

Based on MMM report the school system is serving the school, teacherages, DIAND cabin and Band office, Bell Canada facility and Hudson's Bay Company system, plus approximately a dozen private Honda generators (mostly 500 w size). The Band also owns and runs a 2500 w Honda generator for the period during the summer when the school system is shut down.

An inventory of the generating systems in the community prepared by MMM is presented following:

TABLE 26
Existing Generators at Cat Lake

Location	Users	Manufacturer Type	Capacity
School Site (2 Unites)	School Teacherages, (3 Bldgs.) DIAND Cabin Nursing Station Pump House Band Office	Diesel -Deutz -Serial No. BF6L913 5469462 -6 cylinder -air cooled -2 cycle	112 HP
		Generator -Standard -1500 RPM -Type C305 -Serial No. 38701/2	60 kw 75 KVA 600V/60Hz/3ph
Bell Canada	Telsat Station	Deutz	N/A
Hudson's Bay Company	H.B.C. Store and residence	Onan	3.0 KVA 120/240 V
Band Office	Band office (summer only)	Honda E2500 gas air colled	2500 W 2 KVA 115 volt
Various	Private households	Honda	500 w to 1500 w (mostly 500 w)

*operated during school year only

6.2 Matrix of System Alternatives

Community energy requirements have been estimated in Section 4. This section reviews the feasibility of meeting these requirements by:

- diesel Generators located in the community
- connection to Ontario Hydro grid; and
- peat energy conversion centre.

The following figures present a summary matrix of the above energy systems, evaluation criteria and preliminary conclusions.

The selected energy systems are evaluated in detail in Section 7.

matrix of system alternatives Cat lake

		SYSTEM	EXISTING GOVERNMENT POLICIES	TECHNOLOGY INVENTORY	ECONOMICS	ENVIRON. CONCERNS	BAND CONCERNS	COMMENTS	CONCLUSION
20 AMP SERVICE		DIESEL GENERATORS IN COMMUNITY		PROVEN TECHNOLOGY				STANDARD HYDRO SYSTEM FOR REMOTE COMMUNITIES - USED AS THE DATUM FOR COMPARISON	TO BE EVALUATED
		ONTARIO HYDRO GRID CONNECTION						RURAL HYDRO RATES APPLICABLE - ONLY 100 AMP SERVICE TO BE CONSIDERED	REJECTED
		PEAT FIRED BOILER AND STEAM ENGINE ELECTRICAL GENERATOR							
20 AMP SERVICE - P.E.C.C. LOCATED	IN COMMUN.	FOR SYSTEM ALTERNATIVES SEE THE FOLLOWING		PROVEN TECHNOLOGY			REJECTED BY BAND		REJECTED
	NORTH OF AIRPORT	POWER AND PEAT SPACE HEATING			MORE ECONOMIC THAN BOG LOCATION	BETTER THAN IN COMMUNITY	BAND REQUESTED 100 AMP SERVICE	VIABLE	TO BE EVALUATED
		POWER AND WASTE HEAT FOR MAJOR BUUILDINGS						DISTANCE TOO GREAT TO JUSTIFY	REJECTED
		POWER AND WASTE HEAT FOR GREENHOUSE						VIABLE	TO BE EVALUATED
		POWER AND SPACE HEATING BY ELECTR. FOR MAJOR BLDGS.						NOT APPLICABLE	REJECTED
		POWER AND SPACE HEATING BY ELECTR. FOR ALL BLDGS.						NOT APPLICABLE	REJECTED
	AT BOG	POWER AND PEAT SPACE HEATING			LESS ECONOMIC THAN AIRPORT OR COMMUNITY LOCATIONS			NOT ECONOMIC DUE TO THE EXTRA 10 km OF TRANSMISSION AND NEED FOR WINTER ROAD NOT CONVENIENT FOR PERSONNEL	REJECTED
		POWER AND WASTE HEAT FOR GREENHOUSE							
		POWER AND SPACE HEATING BY ELECTR. FOR MAJOR BLDGS.							
		POWER AND SPACE HEATING BY ELECTR. FOR ALL BLDGS.							
100 AMP SERVICE - P.E.C.C. LOCATED	IN COMMUN.	FOR SYSTEM ALTERNATIVES SEE THE FOLLOWING	AVAILABLE FROM ONTARIO HYDRO BUT CONTRARY TO NORM DUE TO PREMIUM COST	PROVEN TECHNOLOGY			REJECTED BY BAND		REJECTED
	NORTH OF AIRPORT	POWER AND PEAT SPACE HEATING			MORE ECONOMIC THAN BOG LOCATION	BETTER THAN IN COMMUNITY		VIABLE	TO BE EVALUATED
		POWER AND WASTE HEAT FOR MAJOR BUILDINGS						DISTANCE TOO GREAT	REJECTED
		POWER AND WASTE HEAT FOR GREENHOUSE						VIABLE	TO BE EVALUATED
		POWER AND SPACE HEATING BY ELECTR. FOR MAJOR BLDGS.						SUPPLEMENTARY HEATING IS POSSIBLE	TO BE EVALUATED
		POWER AND SPACE HEATING BY ELECTR. FOR ALL BLDGS.							
	AT BOG	POWER AND PEAT SPACE HEATING			LESS ECONOMIC THAN AIRPORT OR COMMUNITY LOCATIONS			REJECTED FOR SAME REASON AS 20 AMP SCENARIO	REJECTED
		POWER AND WASTE HEAT FOR GREENHOUSE							
		POWER AND SPACE HEATING BY ELECTR. FOR MAJOR BLDGS.							
		POWER AND SPACE HEATING BY ELECTR. FOR ALL BLDGS.							

FIGURE 7

matrix of system alternatives Cat lake

		SYSTEM	EXISTING GOVERNMENT POLICIES	TECHNOLOGY INVENTORY	ECONOMICS	ENVIRON. CONCERNS	BAND CONCERNS	COMMENTS	CONCLUSION
100 AMP SERVICE		DIESEL GENERATORS IN COMMUNITY		PROVEN TECHNOLOGY				20 AMP SERVICE PROVIDES THE DATUM FOR COMPARISON	REJECTED
		ONTARIO HYDRO GRID CONNECTION						INSUFFICIENT NO. OF CUST. FOR HYDRO DIAND TO PROVIDE CAPITAL AND ONE TIME OPERATING $	TO BE EVALUATED
		PEAT FIRED GASIFIER AND GAS OPERATED ENGINE/GENERATOR							
20 AMP SERVICE - P.E.C.C. LOCATED	IN COMMUN.	FOR SYSTEM ALTERNATIVES SEE THE FOLLOWING		EVOLVING TECHNOLOGY WHICH REQUIRES FURTHER DEVELOPMENT			REJECTED BY BAND		REJECTED
	NORTH OF AIRPORT	POWER AND PEAT SPACE HEATING			MORE ECONOMIC THAN BOG LOCATION	BETTER THAN IN COMMUNITY	BAND REQUESTED 100 AMP SERVICE	VIABLE	TO BE EVALUATED
		POWER AND WASTE HEAT FOR MAJOR BUUILDINGS						DISTANCE TOO GREAT TO JUSTIFY	REJECTED
		POWER AND WASTE HEAT FOR GREENHOUSE						VIABLE	TO BE EVALUATED
		POWER AND SPACE HEATING BY ELECTR. FOR MAJOR BLDGS.						NOT APPLICABLE	REJECTED
		POWER AND SPACE HEATING BY ELECTR. FOR ALL BLDGS.						NOT APPLICABLE	REJECTED
	AT BOG	POWER AND PEAT SPACE HEATING			LESS ECONOMIC THAN AIRPORT OR COMMUNITY LOCATIONS			NOT ECONOMIC DUE TO THE EXTRA 10 km OF TRANSMISSION AND NEED FOR WINTER ROAD NOT CONVENIENT FOR PERSONNEL	REJECTED
		POWER AND WASTE HEAT FOR GREENHOUSE							
		POWER AND SPACE HEATING BY ELECTR. FOR MAJOR BLDGS.							
		POWER AND SPACE HEATING BY ELECTR. FOR ALL BLDGS.							
100 AMP SERVICE - P.E.C.C. LOCATED	IN COMMUN.	FOR SYSTEM ALTERNATIVES SEE THE FOLLOWING	AVAILABLE FROM ONTARIO HYDRO BUT CONTRARY TO NORM DUE TO PREMIUM COST				REJECTED BY BAND		REJECTED
	NORTH OF AIRPORT	POWER AND PEAT SPACE HEATING			MORE ECONOMIC THAN BOG LOCATION	BETTER THAN IN COMMUNITY		VIABLE	TO BE EVALUATED
		POWER AND WASTE HEAT FOR MAJOR BUILDINGS						DISTANCE TOO GREAT	REJECTED
		POWER AND WASTE HEAT FOR GREENHOUSE						VIABLE	TO BE EVALUATED
		POWER AND SPACE HEATING BY ELECTR. FOR MAJOR BLDGS.						SUPPLEMENTARY HEATING IS POSSIBLE	TO BE EVALUATED
		POWER AND SPACE HEATING BY ELECTR. FOR ALL BLDGS.							
	AT BOG	POWER AND PEAT SPACE HEATING			LESS ECONOMIC THAN AIRPORT OR COMMUNITY LOCATIONS			REJECTED FOR SAME REASON AS 20 AMP SCENARIO	REJECTED
		POWER AND WASTE HEAT FOR GREENHOUSE							
		POWER AND SPACE HEATING BY ELECTR. FOR MAJOR BLDGS.							
		POWER AND SPACE HEATING BY ELECTR. FOR ALL BLDGS.							

FIGURE 8

7.0 SELECTED ENERGY SYSTEM

7.2.1 Ontario Hydro Grid Connection

7.2.1.1 System Description

Cat Lake is located approximately 65 km from the nearest 115 KV transmission line and approximately 75 km from a 44 KV transmission line at Pickle Lake where a substation is available for connection. The cost of transmission lines depends to some extent on the voltage level, however, for the distances involved the transmission voltage must be kept reasonably high.

7.2.1.2 Capital Cost Estimate

Cost estimates and revenue projections contained in this section are based on the following:

a) Capital costs are for a construction start in 1985 and a system startup in 1988 of a facility designed to meet 1990 requirements.

b) Operating costs are for the year 1984 and will be escalated by the IFPS program so that meaningful comparisons can be made with other options.

c) Expansion costs are given for the period 1990 to 2000.

d) All hardware costs contain Federal and Provincial Sales Taxes.

The cost of high voltage line construction is dependent on so many variables that it is necessary to establish a range of costs rather than to attempt to quote a single figure. The following range of costs have been established by Ontario Hydro as representative of those that can be encountered in northern Ontario.

44 KV - $45,000/km to $55,000/km

115 KV - $50,000/km to $60,000/km

These prices include the cost of a standard sized substation.

Suitably small 115 kW substations are not economically available to make it feasible to connect to the nearest Ontario Hydro grid. Therefore, it would be necessary to connect to an existing lower voltage substation at Pickle Lake and transmit to Cat Lake 75 km away. The cost of the line would depend to some extent on the voltage level available at Pickle Lake, but for this distance it would have to be reasonably high and the costs will not deviate significantly from the figures given for 44 KV. This would result in a line construction cost which would vary from:

75 x $45,000 = $3,375,000

75 x $55,000 = $4,125,000

In southern Ontario, under similar circumstances, Ontario Hydro require a prepaid maintenance charge of 1/2% of the capital cost per year of estimated line life. They do not have a multiplier for northern communities, but based on their estimate that construction costs in this area are twice those in southern Ontario, it is reasonable to double the charge to 1% with an estimated line life of twenty five years. This would result in a total upfront cost for power supply between $4,218,750 to $5,156,250 with the average costs of $4,700,000 used for the financial analysis plus the distribution system costs shown in Section 7.2.4

7.2.1.3 Operating Cost Estimate

The treatment of revenue and operating cost projections for this option will be different than for the other three technical options. For this option there is no revenue in the normal sense. However, for comparison purposes it is reasonable to impute income by using the diesel generator cost per kWh rates as revenue and the grid rates as the operating cost component. In effect the net income is then equal to what is saved by being connected to the Ontario Hydro grid as opposed to generating power in the community with a diesel system.

A northern community that is supplied power from a grid connection pays for that power at the standard Rural Hydro rates. Due to the availability of power at rates considerably lower than those normally charged in a community supplied by a diesel generation facility, it is anticipated there would be an increased demand for 100 Amp services. Therefore, the following projections are provided for 1984 on the basis of both the 20 Amp and 100 Amp scenarios developed in Section 4.

20 Amp Scenario

In accordance with the study terms of reference the power consumptions developed in Section 4 are for the milestone years 1985, 1990 and 2000. However, cost estimates and revenue projections in this section are based on 1984 conditions and costs.

For the 1984 power consumption the house consumption for that year has been added to the community building consumption for 1985 on the basis that all community buildings shown as existing in 1985 were in use in 1984.

House Consumption 69 houses x 6,000 kWh = 414,000 kWh

Community building consumption = 135,628

Total 1984 estimated power consumption = 549,628 kWh

Average monthly use = $\frac{549,628}{12}$ = 45,802

88 customers x 1st 250 kWh x $0.105 = $ 2,310

Remainder =[45,802 -(88 x 250)kWh] $.0446 = 1,062

Total/month = $ 3,372

Total/year = $3,372 x 12 = $40,464

100 Amp Scenario

For the same reasons explained for the 20 Amp scenario the power consumption for 1984 would be as follows:

House consumption (power)69 houses x 10,000 kWh = 690,000 kWh

Community Buildings consumption = 135,628

Sub Total 825,628 kWh

Space Heating electricity substitution = $\frac{69}{74}$ x 579,628 = 540,464

Total 1984 estimated power consumption = 1,366,092 kWh

Average monthly use = $\frac{1,366,092}{12}$ = 113,841 kWh

88 customers x 1st 250 kWh x $.105 = $ 2,310

Remainder =[113,841-(88 x 250)kWh] $.0446 = 4,096

Total/month = $ 6,406

Total cost per year = $6,406 x 12 = $76,872

7.2.1.4 Revenue Projections

As described in Section 7.2.1.3 the revenues for this option are calculated by using the diesel generator system rates.

20 Amp Scenario

1984 RESIDENTIAL USE = 414,000 kWh

Average monthly use = $\frac{414,000}{12}$ = 34,500 kWh

69 houses x 1st 250 kWh x $.0886 = $1,528

Remainder =[34,500 - (69 x 250)] .118 = 2,035

Total/month = $3,563

Total/year $3,563 x 12 = $42,756

1984 COMMERCIAL USE = 135,628 kWh

Private Commercial Portion = 26,307 kWh

26,307 x $.295 = $ 7,761

Government Agency Portion = 109,321 kWh

109,321 x $.442 = 48,320

Total/year $56,080

TOTAL REVENUE

Residential	$42,756
Commercial	56,080
Total	$98,836

100 Amp Scenario

For the same reasons explained for the 20 Amp scenario the power consumption for 1984 would be as follows:

House consumption (power) 69 houses x 10,000 kWh = 690,000 kWh

Community Buildings consumption = 135,628

Sub Total 825,628 kWh

Space Heating electricity substitution = $\frac{69}{74}$ x 579,628 = 540,464

Total 1984 estimated power consumption = 1,366,092 kWh

Average monthly use = $\frac{1,366,092}{12}$ = 113,841 kWh

88 customers x 1st 250 kWh x $.0886 = $ 1,949

Remainder =[113,841-(88 x 250)kWh] $.118 = 10,837

Total/month = $12,786

Total cost per year = $12,786 x 12 = $153,432

7.2.2 Ontario Hydro Diesel Generation Plant

7.2.2.1 Northern Community Policy

There is no policy covering the electrification of northern communities which has been formally accepted by all of the various parties involved in a project of this type. However, Ontario Hydro have issued documentation that covers their definition of this policy which has not been challenged and it is as follows:

1) The capital cost of any type of electrification facility installed in a northern native community is borne by DIAND. On completion of the construction of a facility it is turned over to Ontario Hydro to operate, who are then responsible for all the operating and maintenance costs. Thus, the decision to extend the existing grid to service one of these communities is based on a financial comparison with the other alternatives and not on unit density which is the standard Hydro approach.

2) The installation of a diesel generation facility is dependent on the existence of at least thirty five permanent customers.

3) Power supplied to all customers by isolated generation shall not be used for the operation of electric storage water heaters and/or permanently installed electric space heating equipment. Small unattended buildings designed for equipment housing may, by special application, be allowed to use electric space heating, but power for the space heating must be paid for at the full rate.

4) Customers on restricted residential service in isolated generation situations are further restricted by a service entrance breaker of 20 amps.

5) There are two classifications of unrestricted service for communities on isolated generation systems, (limited to 100 amps), which are charged at two different rates, (Appendix G).

6) Because of the difference in the cost of transportation of diesel fuel there are two different rate structures for isolated generation communities; one for those serviced by air and another for those serviced by rail or road. Refer to Appendix G for these rate structures.

7) Diesel generation facilities that will be installed for an isolated generation community will consist of three generators of varying size. The largest unit is sized to accommodate the full load and the other two are sized to total slightly more than the maximum capacity of the largest. Ontario Hydro have standardized 600, 400, 250, 175, 125, and 85 kW sizes.

8) Generation facilities are sized to meet current needs with some spare capacity but not on the basis of predicted population growth.

9) A landing strip of at least 1000 meters (not necessarily paved) is required for each community serviced by an Ontario Hydro operated remote generation facility that does not have road or rail access.

10) Power charges in a community that is serviced from an extension to the existing grid are the regular rural Ontario Hydro rates.

7.2.2.2 System Description

The system shown on the attached single line sketch and covered by the equipment list is in general based on the Ontario Hydro policy for northern communities and in keeping with their specifications for this type of installation.

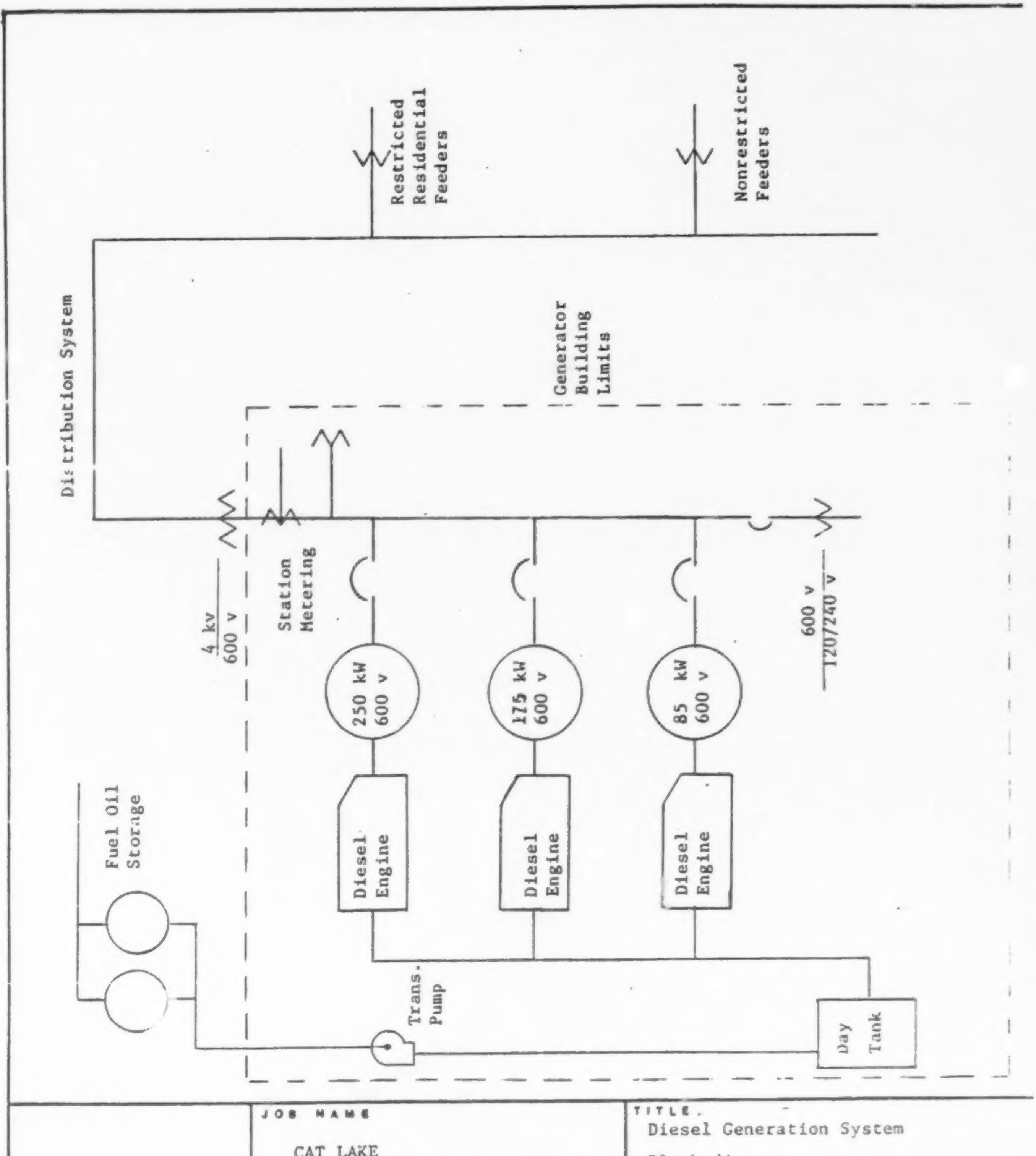
It has been sized per Hydro's approach (see Section 7.2.2.1.) to meet the 1990 power requirements of Cat Lake with some spare capacity which would also be adequate up to the year 2000.

In addition to the standard features covered by the Ontario Hydro specification, station production and demand metering have been added as well as unit auto start and paralleling. Generation voltage is 600 and distribution voltage is 4160.

TABLE 27

Proposed System Equipment List

Quantity	Size	Description
1	250 kW	diesel generator set
1	175 kW	diesel generator set
1	85 kW	diesel generator set
3	to suit	diesel exhaust system
2	20,000 l	fuel oil storage tank
1	90 l/min	fuel oil transfer pump
3	1000 l	fuel oil day tank
1	2500 m	1/2" fuel oil piping
3	120 v	battery trickle charger
4	600 a	600 v switchgear
1	15 kva	600 v - 120/240 v transformer
1	750 kva	600 v/4160 v transformer (refer to Section 7.2.4)
1	800 kW	station metering cabinet
1	7.5 x 12 m	generator building
1	4160 v	distribution system (refer to Section 7.2.4)


Distribution System
Restricted Residential Feeders
Nonrestricted Feeders
Generator Building Limits
4 kv
600 v
Station Metering
250 kW 600 v
175 kW 600 v
85 kW 600 v
600 v
120/240 v
Diesel Engine
Diesel Engine
Diesel Engine
Fuel Oil Storage
Trans. Pump
Day Tank

JOB NAME
CAT LAKE

TITLE.
Diesel Generation System
Block diagram

DATE
May 31, 1984

SCALE

Maunder & Britnell
Engineering Limited

DRAWN BY
G.G. Page

CHECKED

DRAWING NUMBER
3

PROJECT NUMBER
84004

7.2.2.3 Exhaust Gas Emissions

Gaseous exhaust emissions of diesel engines are the lowest of modern internal combustion engines. For example on a properly tuned engine at rated load the performance should be approximately as shown below in grams/M^3 of exhaust gases.

	FUEL		
	GASOLINE	**DIESEL**	**NATURAL GAS**
Nitrogen oxide	.0068	.002 to .0015	.049
Carbon Monoxide	.0012	.0016 to .0011	.048
Hydrocarbons	.0002	.0012 to .0009	.0029

The environmental impact of these emissions can be assessed by comparing them to the data for the peat burning facility covered in a subsequent section of this report.

7.2.2.4 Technology Integrity

This is not a subject that lends itself to quantification with hard numbers but must be addressed in more of a qualitative manner.

Diesel electric systems are well proven with many years of technological development behind them. The operation is very reliable and service and maintenance intervals are quite predictable. Pending some unusual occurrence the system can be expected to provide the required service better than 99% of the time with a minimum of manual attendance.

Diesel engines do require regular and fairly frequent maintenance, but if this is performed conscientiously they will last for many years. Reference to Section 7.2.2.6 will provide some insight into the costs involved in providing the appropriate level of maintenance.

7.2.2.5 Personnel Requirements

Operating and maintenance personnel requirements have been taken from an 1982 Ontario Hydro Study entitled "Isolated Distribution Systems Northeastern and Northwestern Regions", and these requirements are summarized below.

Technical Support	**Annual Manhours/Site**
Follow-up on equipment warranties and other malfunctions	
Provide functional guidance	
Check operational reports	
Deal with correspondence from outside agencies	
Attend Regional meetings	
	170
Plant Maintenance	
2,000 hour inspection	
4,000 hour inspection	
6,000 hour inspection	
Major overhaul	
Monthly preventive maintenance	
Trouble calls	
	1,500
Administrative Support	
Prepare cheques for work performed by agents	
Preparation and typing of labour contracts	
Process fuel invoices	
Process lubrication oil deliveries	
Prepare Air Flight Report	
Check invoices, expense reports, etc.	
Check lubricating oil invoices	
Provide input to preparation of employment contracts with local agents	
Provide input to work program and budget	
Prepare year-end summaries	
Prepare material relating to fuel purchases	
	144

Customer Service

- Follow-up meter reading contracts
- Attend meetings with DIAND
- Answer enquiries from various groups
- Telephone calls relating to remotes
- Annual review of kWh consumption
- Follow-up on problem relating to deposits
- General involvement in new services
- Follow-up on delinquent commercial accounts
- Follow-up on delinquent residential accounts
- Calculate commercial bills
- Arrange air transportation
- Prepare work order estimates
- Prepare serviced layouts
- Update location maps
- Check high billing complaints
- Check demand meters for commercial customer
- Disconnects

250

Electrical Inspection 40

Area Manager

- Attend meetings with DIAND
- Visits to communities
- Attend Regional meetings
- Supervision of staff involved with remotes
- Telephone discussions with DIAND & other government groups

50

Area Office Supervisor

- Arrange for payment of local agents
- Monitor and arrange for payment to Band Council for work carried out locally
- Monitor equipment used for distribution system extensions
- Collect & record capital contribution made
- Attend meetings with DIAND
- Billing - check meter readings sent to calculate bills
- Prepare bill & mark-up customer's individual ledgers card

30

Customer Billing 400

Meter Data 10

Typing 30

Total Annual Manhours/Site 2,584

7.2.2.6 Capital Cost Estimate

The following capital cost estimate is based on the system described in Section 7.2.2.2 and takes into account the rules outlined in Section 7.2.1.1 and the assumptions as follows:

- Equipment will be available on site for excavating and backfilling foundations, trenches and pole holes.
- Tradesmen for building construction, electrical and mechanical installation and system startup will have to be brought in from outside.
- There is sufficient suitable granular material on site to do the necessary concrete work and backfilling.
- Construction will start in 1985 and be completed for plant startup the first of 1988.

TABLE 28

Account No.	**Description**	**Budget**
070-080	Building & building services	$75,600
100	Fuel Oil Storage & Transportaion System	4,700
200	Diesel Generators (3)	266,728
300	Switchgear	94,200
1100	Installation, Travel & Living	120,000
1150	Band Labour	57,700
1500	Engineering & Contingencies	154,732
	Total	$773,660

NOTE: In order to establish the total system cost, prices for the distribution system shown in Section 7.2.4 must be added to the above.

CONFIGURATION ON WHICH CAPITAL COST ESTIMATE IS BASED

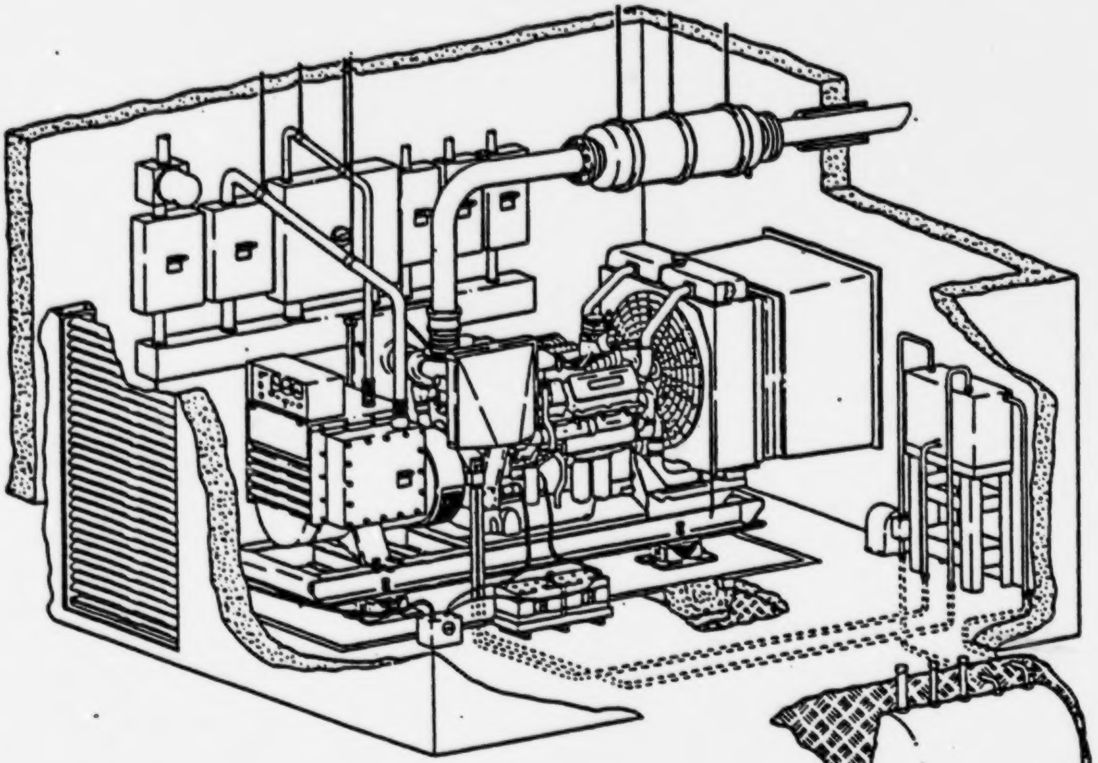


FIGURE 9

7.2.2.7 Operating Cost Estimate

Fuel Costs

The Ontario Hydro operating data for 1983 shows that for communities equivalent in size to Cat Lake fuel consumption is one litre for every 2.25 kWh of power generated. With an estimated 1984 power consumption of 549,628 kWh the fuel consumption will equal 244,280 litres for a total annual cost of $127,026 based on a 1984 price of 52 cents per litre of diesel fuel delivered to Cat Lake.

Personnel Costs

The following costs for operating and maintenance personnel have been developed using the manhour estimates outlined in Section 7.2.2.5

TABLE 29

Work Item	Manhours	Cost
Technical Support	170	$ 5,950
Plant Maintenance	1,500	52,500
Administrative Support	144	3,000
Customer Service	250	5,000
Electrical Inspection	40	1,200
Area Manager	50	1,500
Area Office Supervisor	30	750
Customer Billing	400	4,000
Meter Data	10	100
Typing	30	240
TOTAL	2,584	$74,240

Travel and Living Expenses

Approximately 25% of the above manhours are area or district office hours and don't involve any travel. Of the remaining 1,940 hours it has been assumed that on the average every 40 manhours will require a return trip from Pickle Lake to Cat Lake for two people and every second trip will result in an overnight stay for one person.

Travel & Living Cost = $10,500

Parts and Materials

Parts and materials have been estimated at 20% of the labour costs in keeping with experience in industrial environments.

Parts and Material Cost = $14,848

Insurance

Insurance at $6/$1,000 of Capital Cost = $7,582 per year

Total Operating Costs

The total operating costs, exclusive of the distribution system, as a sum of the foregoing = $234,196.

Annual operating costs associated with the distribution system would be $9,520 per Section 7.2.4.1.5.

Figures taken from Ontario Hydro's 1983 Operating Statement show that the total operating cost for all northern communities was $4,134,856 and the total power consumed was 11,227,251 kWh, which results in a rate of 36.8 cents per kWh. This rate escalated to 1984 prices gives approximately 39.6 cents per kWh which would result in a total operating cost of $229,533 for the 1989 estimated consumption of 549,628 kWh. However, this total must be reduced to $220,013 by the distribution system operating cost of $9,520 so that it can be compared to the manhour estimate. These two estimates are less than 1% apart which provides reasonable assurance that the manhour estimates are quite accurate.

7.2.2.8 Revenue Projections

The following revenue projections are based entirely on the assumption that the diesel Generation System has been installed and will be operated by Ontario Hydro and that they will be reimbursed by the individuals or Agencies at the standard rates shown in Appendix G for the northern communities.

1984 RESIDENTIAL USE = 414,000 kWh

Average monthly use = $\frac{414,000}{12}$ = 34,500 kWh

69 houses x 1st 250 kWh x $.0886 = $1,528

Remainder =[34,500 - (69 x 250)] .118 = 2,035

Total/month = $3,563

Total/year $3,563 x 12 = $42,756

1984 COMMERCIAL USE = 135,628 kWh

Private Commercial Portion = 26,307 kWh

26,307 x $.295 = $ 7,761

Government Agency Portion = 109,321 kWh

109,321 x $.442 = 48,320

Total/year $56,080

TOTAL REVENUE

Residential	$42,756
Commercial	56,080
Total	$98,836

7.2.2.9 Turndown and Growth Capability

7.2.2.9.1 Turndown

The station is designed on the basis of the Ontario Hydro current policy of installing three different sized units; in this case going from 85 kW to 250 kW for a total capacity of 510 kW.

Assuming a 10% overrun capability this would mean that the plant could run from a maximum of 561 kW down to 20% of the smallest unit for a minimum of 17 kW. This represents a turndown of 33:1. However, from a practical point the operating ranges of the units should be more per the following in order to maintain operating efficiency andengine life.

Rating	85 kW unit	175 kW unit	250 kW unit
Operating Range	65 kW to 85 kW	130 kW to 175 kW	185 kW to 250 kW

This gives an operating range of 65 kW to 510 kW which represents a turndown of approximately 8:1.

7.2.2.9.2 Growth

The system can be increased to whatever size is required by exchanging smaller generators for larger ones or by adding more generators and transformers and increasing the size of the building and the distribution system. However, there are some practical limits to the amount of expansion possible imposed by following the Ontario Hydro policy and by the initial configurations chosen.

The approach taken for the proposed diesel system is to design the building with the capacity to ultimately accomodate two 250 kW generators and one 400 kW generator with one transformer sized for 750 kva, (which is the largest standard size below a 1,000 kva unit). If the system were to grow beyond this size then the building construction is such that it can be expanded to house larger and/or more generators and an additional transformer or transformers can also be added.

In summary practical expansion would be up to 750 kW within the proposed building and using the proposed transformer, and up to 1,800 kW using the Ontario Hydro group of three maximum standard size generators and the appropriate transformers. The ultimate size will meet the projected Cat Lake requirements up to the year 2000.

7.2.3 - Peat Based Electrical Generation

7.2.3.1 - Peat Fired Gasifier and Gas Operated Engine Generator

7.2.3.1.1 - Peat Storage & Handling System Description

The fuel peat as required for electrical generation and for space heating in the community will be delivered to a storage area adjacent to the Peat Energy Conversion Centre (P.E.C.C.). The peat, as noted earlier, will be supplied as "sod peat", that is in extruded cylindrical sections. It is intended that the peat remain on the bog for drying from solar heat. The "sods" will then be piled in racks or in some convenient container for ease of handling from bog to storage and from storage to point of use.

The peat will be handled in racks or preassembled containers by means of a fork lift vehicle. The containers will be piled 2 high, approximately 2 meters, and covered with a plastic cover. Suitable drains will be provided around the storage area to insure that water does not accumulate at the base of the piles.

One operator would be required to oversee the peat loading operation. Peat would be loaded on a continuous basis into a live bottom receiving bin which discharges onto a belt conveyor feeding the dryer.

Peat will be harvested at approximately 50% moisture content wet basis. The gasifier operation requires peat chunks (about 4 inch square, dried to an ideal 17% moisture content wet basis and a maximum of 10% fines content. The wet peat sods will break down into cubes of acceptable size for the gasifier when handled by the receiving and feed equipment. A moving grate type dryer, fired by peat fines screened off the process line, is proposed for the dryer system. The dryer's wet cell burner firing rate will be controlled by the dryer outlet air temperature.

Peat at 17% moisture would be conveyed from the dryer to a screen to remove fines for dryer burner fuel. The screened peat will then be automatically conveyed to the gasifier fuel metering bin.

7.2.3.1.2 - Energy Conversion System

Figure 1 on the following page illustrates the process flow. There are North American, French, German and Italian manufacturers of gasifiers. This discussion is based on the German Imbert System.

The immediate feed to the gasifier consists of a hopper with a guillotine valve. The valve and associated feed conveyor are controlled by peat fuel level in the hopper.

The solid fuel in the gasifier chamber carbonizes to charcoal and then gasifies. The charcoal is ignited when the unit is first put in operation. Air entering the gasifier furnace combines with the charcoal to produce combustible carbon monoxide and noncombustible carbon dioxide. The gasifier operates by controlling suction air pressure in response to the rate of gas flow to the generator. The released water, steam and carbonized gases travel through the burning charcoal at such high temperatures that even at low load operation, the steam is partly reduced into hydrogen and oxygen. The oxygen released supports the gasification of the charcoal. In addition to carbon monoxide, methane CH4 (combustible) is generated in small quantities.

The discharge gas is delivered to a heat exchanger (for preheating combustion air to the gasifier) then to a cyclone for removal of ash and tar contaminates and then to a gas cooler and condenser. A compressor then delivers the gas to a dual-fuel engine/ generator set. The engine would operate on 65-70% gasifier produced gas. The remainder fuel requirement would be supplied by No. 6 fuel oil. Diesel fuel oil is not recommended as the secondary fuel because the diesel fuel injectors tend to block when operated in conjunction with the producer gas. The engine will also operate on 100% fuel oil when the gasifier is out of operation.

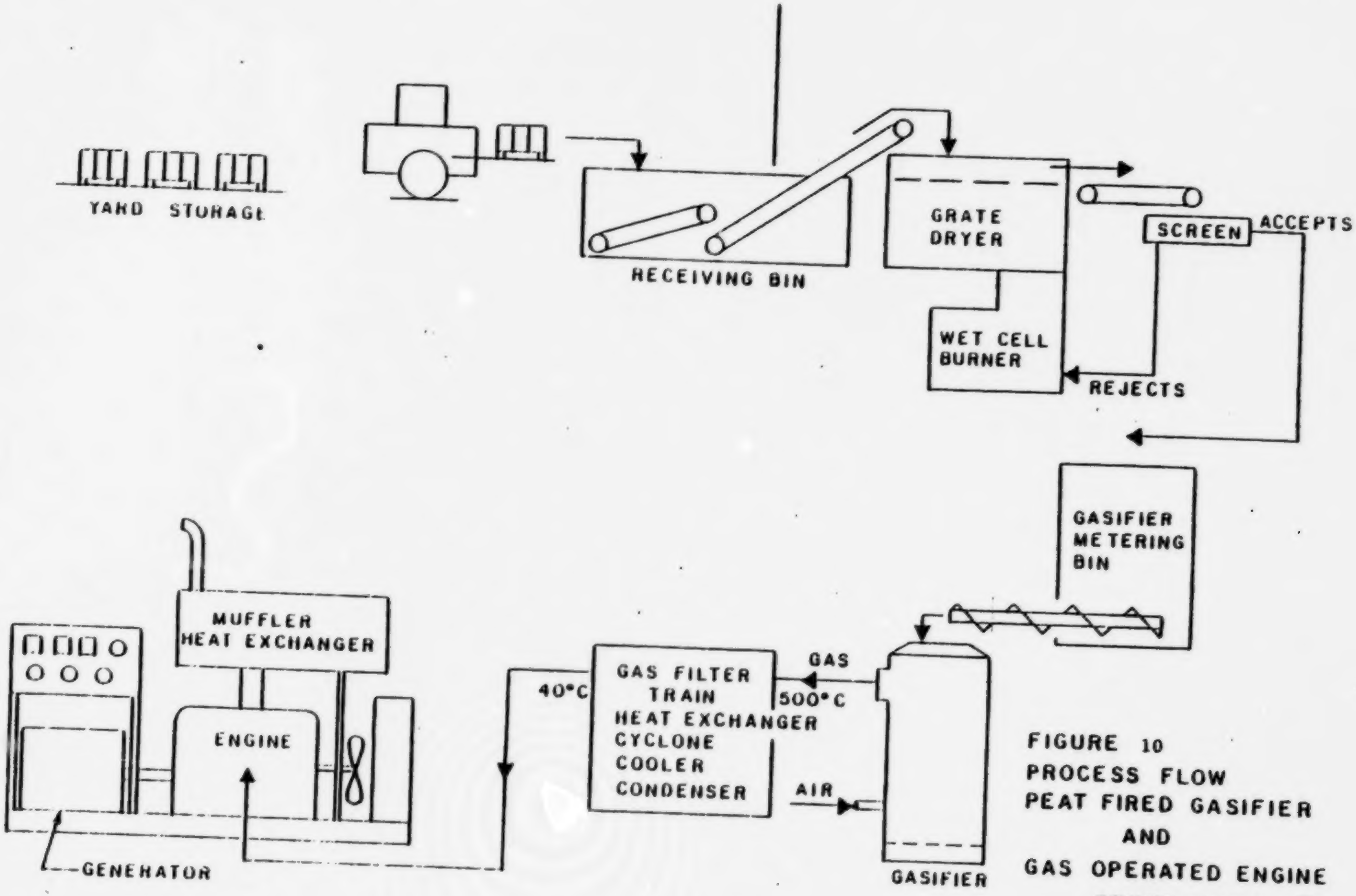

YARD STORAGE
RECEIVING BIN
GRATE DRYER
WET CELL BURNER
SCREEN
ACCEPTS
REJECTS
GASIFIER METERING BIN
GASIFIER
GAS
500°C
AIR
GAS FILTER TRAIN
HEAT EXCHANGER
CYCLONE
COOLER
CONDENSER
40°C
MUFFLER HEAT EXCHANGER
ENGINE
GENERATOR

FIGURE 10
PROCESS FLOW
PEAT FIRED GASIFIER
AND
GAS OPERATED ENGINE
GENERATOR
CAT LAKE

AHI 2254-1

7.2.3.1.3 - Technology Integrity

There are no gasifiers operating on a commercial basis in North America. In 1982 there was a very active research installation in Minnesota. However, the plant did not operate in 1983. The plant manager is optimistic that the unit will be restarted in summer 1984, and an extensive test programme pursued. The gasifier operates a 150 kW engine generator and is fueled by a variety of materials from sod peat to pelletized cat-tails. Although the unit had been tested intermittently, a full one week's operating performance data is not yet available.

In May, 1984 gasifier status was reviewed with Mr. B. Thompson, who worked with Biomass Inc. in the late seventies, early eighties. Biomass Inc. sold eight gasifiers to North American installations. All eight were operated briefly on a research basis. The US Federal alternate energy programme priorities changed in the early eighties and federal assistance for gasifier test/research programmes is no longer available.

ADI Limited in 1980 carried out an extensive test/trials monitoring programme on the France manufactured Hurry Road, P.E.I. gasifier installation which was manufacturer/contractor engineered. The Hurry Road installation has had persistent problems with fuel moisture content variations, and gas quality fluctuations. The gasifier has not been restarted since the monitor programme concluded.

It is understood from discussions with Mr. Scott Stevens that a gasifier installation is due for testing in August this year. The gasifier and engine used in this project have still not been fully tested as a system and support information from the project will not be available until September at the earliest.

Gasifier technology is still in the research and development stage. Installation of a gasifier to meet the Cat Lake electrical generation need is not recommended.

7.2.3.1.4 - Heat Recovery

Heat would be recovered from:

(1) the gasifier exhaust gases
(2) the fines screened from the peat fuel

1. A heat exchanger would be in the gasifier discharge line to preheat combustion air feeding the gasifier furnace. Gases leave the gasifier at about 500°C and must be cooled to about 40°C before delivery to the gas engine.

2. The lower the fines content of the peat delivered to the gasifier, the better the gasifier performance. It is proposed to collect sufficient fines, both wet and dry, to provide fuel to a wet cell burner which will serve the peat dryer.

7.2.3.1.5 - Flue Gas Emissions and Ash Residues

(a) The engine exhaust gases typically consist of CO, $CO2$ and $O2$ with a CO content less than 3%, $O2$ about 10% and $CO2$ about 10% on a volumetric basis.

(b) There is not enough practical operating data from a peat-fired gasifier installation to report reliable figures on percentages and compositions of ash residues. Biomas Inc., a gasifier manufacturer, suggested that laboratory tests be performed using peat from the Cat Lake district, to ascertain typical ash compositions. For information, discharges from a wood fired gasifier test have been recorded as:

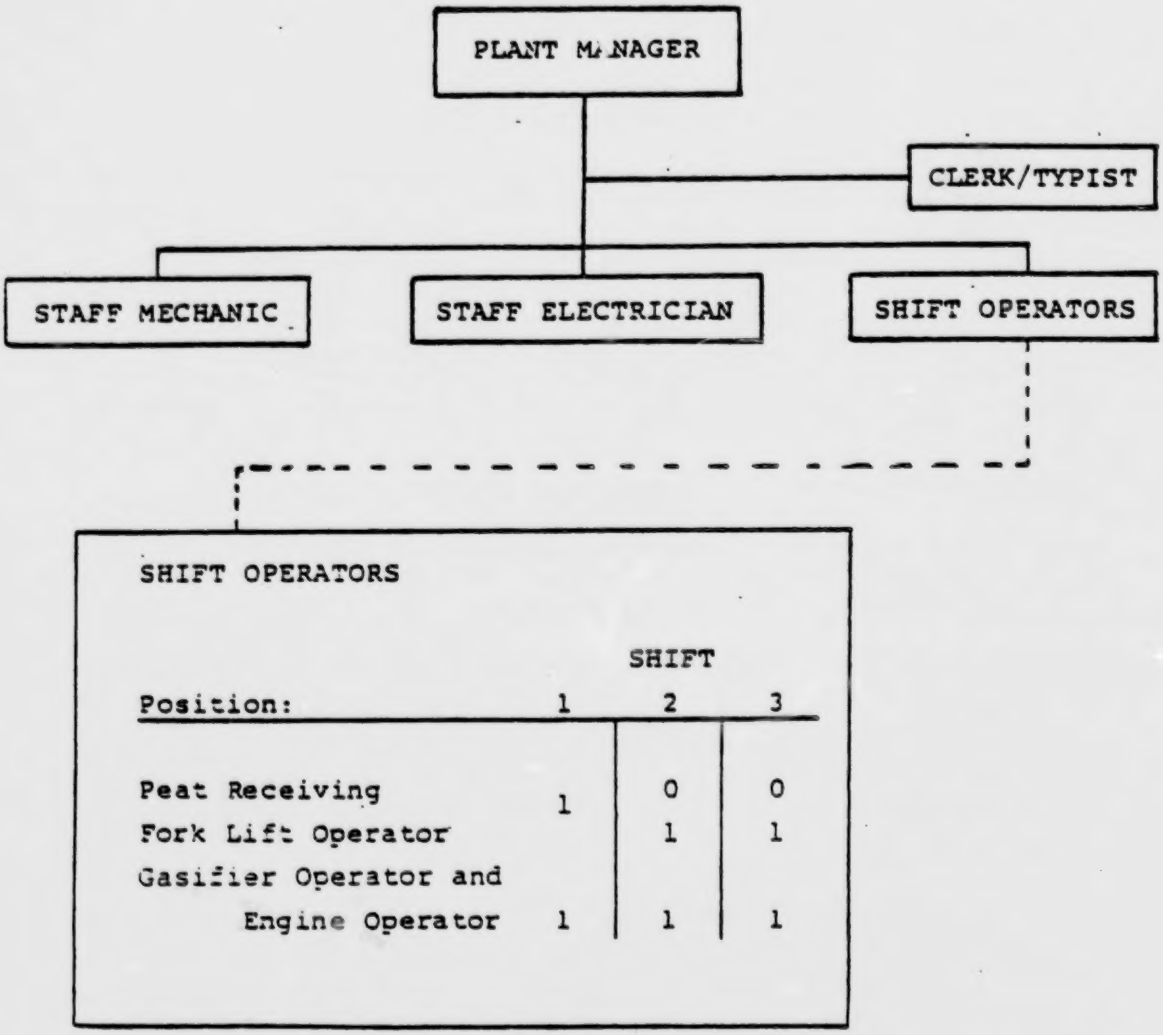
1% ash/weight of fuel
0.9% dust at the cyclone
220 g water for 1 Kg wood, collected at the condenser.

7.2.3.1.6 - Institutional Structure and Personnel Requirements

It is assumed that the facility would be operated and owned by DIAND. It would require personnel as follows:

- a plant manager
- a clerk typist
- four operators for the gasifier/engine generator set one per shift plus one operator to cover the swing shift
- two peat handlers (labourers)
- one electrician
- one mechanic

7.2.3.1.6 Institutional Structure and Personnel Requirements


PLANT MANAGER
CLERK/TYPIST
STAFF MECHANIC
STAFF ELECTRICIAN
SHIFT OPERATORS

SHIFT OPERATORS

	SHIFT		
Position:	1	2	3
Peat Receiving	1	0	0
Fork Lift Operator		1	1
Gasifier Operator and Engine Operator	1	1	1

FIGURE 11

7.2.3.1.7 - Capital Cost Estimate
a) - 100 Amp Scenario

Account No.	Description	Budget
070	Site preparation	$ 225 000
080	Buildings and structures with Northern Construction Allowance	400 000
090	Mobile equipment	25 000
100	Fuel receiving	60 000
200	Peat handling equipment	75 000
300	Dryer and wet cell burner	800 000
400	Gasifier and gas train	1 400 000
500	Gas engine generator set	200 000
600	Building services	60 000
700	Electrical	150 000
800	Maintenance shop	10 000
900	Office equipment	3 000
1000	Startup services	12 000
1100	Installation contracts plus Northern Construction allowance	210 000
1200	Spare parts	50 000
1300	Operator training programme	20 000
1400	Equipment transportation to Cat Lake	250 000
1500	Engineering & Contingencies	988 000
	TOTAL	$4 938 000

TABLE 30

070 - The figure carried for site preparation is only an allowance and will vary with actual site conditions. The work allowance is for site survey and soils investigation, excavation and rough grading, gravel and drainage, fire ponds, finish grading, and a fence around the peat receiving yard. There is no allowance for site access roads or landscaping.

080 - Building cost estimates are based on discussions with building contractors from Thunder Bay who have been involved with building metal buildings in Northern Ontario. The figures represent approximate costs of $75/square foot for pre-engineered type metal buildings. The following assumptions were made in arriving at these costs:

1. all materials would be flown to the site.
2. construction of the airport at Cat Lake would be completed prior to construction of this project.
3. a relatively nearby source of gravel would be available for granular fill and concrete aggregate.
4. earthwork equipment used for airport construction would be available on a rental basis.

One other contractor in Thunder Bay was contacted. He cautioned that if all materials and equipment had to be taken into Cat Lake from the south, then costs could escalate to $125/square foot in Cat Lake.

090 - Mobile Equipment
A single forklift truck will be sufficient to move wet peat racks from yard storage to the receiving bin and to look after ash bin disposal.

100 - The fuel receiving equipment proposed will consist of diesel fuel oil storage tanks, a truck scale and a portable moisture analyzer.

200 - The peat handling equipment proposed includes the conveying and bin storage components. It is proposed to fabricate the equipment in Thunder Bay or some other center with as direct as possible shipping access to Cat Lake.

300
The dryer proposed would be complete with a control system to modulate peat infeed flow rate in proportion to dryer outlet air temperature (which is dependent on the moisture content of the peat at the outlet of the dryer). This control system will produce peat at the dryer outlet at moisture contents within ± 10% of the set point moisture content - despite variations in the moisture content of peat into the dryer.

The dryer would be fired by a wet cell burner. The burner would be fueled by wet and dry fines screened off the process line.

400 - Gasifier and Gas Train
The price carried for the gasifier and gas train is based on $2000/kW. This price was received in May 1984 from Biomass Inc., a gasifier manufacturer.

600 - The building services allowance includes a sprinkler system, an air compressor, an air handling unit for the gasifier room, some small unit heaters for employee offices and employee washroom fixtures.

700 - The electrical services cost covers building interior lighting and a small amount of exterior security floodlighting. A main electrical switchboard and motor control centers plus an operator console for the peat handling equipment is also included.

800 - The maintenance shop cost includes hand tools, a drill press, a hydraulic press and welding supplies.

900 - The office equipment cost includes files, desks, a typewriter, telex machine, calculator and a dozen hardhats.

1000 - Startup service costs are sufficient to include representatives from the gasifier and gas engine/ generator set manufacturer, and the peat handling system designer representative.

1100 - Both mechanical and electrical installation contracts are covered in this figure.

1200 - Spare parts costs are allowed for at 5% of the total machinery costs.

1300 - The operator training programme would consist of a 5-day session.

1400 - The cost figure carried for equipment transportation allows for equipment delivery by air and winter road via Thunder Bay - Pickle Lake - Cat Lake. All equipment costs carried in the estimate are FOB Thunder Bay.

7.2.3.1.7 - Capital Cost Estimate
b) - 20 Amp Scenario

Account No.	Description	Budget
070	Site preparation	$ 225 000
080	Buildings and structures with Northern Construction Allowance	400 000
090	Mobile equipment	25 000
100	Fuel receiving	60 000
200	Peat handling equipment	70 000
300	Dryer and wet cell burner	600 000
400	Gasifier and gas train	300 000
500	Gas engine generator set	100 000
600	Building services	60 000
700	Electrical	150 000
800	Maintenance shop	10 000
900	Office equipment	3 000
1000	Startup services	12 000
1100	Installation contracts plus Northern Construction allowance	210 000
1200	Spare parts	40 000
1300	Operator training programme	20 000
1400	Equipment transportation to Cat Lake	250 000
1500	Engineering & Contingencies	635 000
	TOTAL	$3 170 000 *

* Federal & Provincial Sales Taxes are included

TABLE 31

7.2.3.1.8 - Operating Cost Estimate

20 Amp Scenario (Gasifier)

Based on 8760 hrs/yr operation

Direct Production Costs	
a) Fuel	
1100 tonnes Peat @ $35/tonne 50% M.C.W.B.	38,500
116,000 litres No. 6 fuel oil @ $ .50/litre	58,000
b) Operating Staff	
Four gasifier/engine operators @ $20,000/year	80,000
Four peat handlers (labourers) @ 8/hour	70,800
c) Expendable Materials Allowance	15,000
Diesel, hydraulic oil and fuel for mobile equipment	
d) Maintenance Allowance	2,500
(None of the North American gasifiers have operated for a long enough period to provide maintenance cost data.)	
Fixed Annual Costs	
a) Administration	
Plant Manager	30,000
Clerk/Typist	14,000
Electrician	20,000
Mechanic	20,000
b) Insurance @ $6/1,000 of capital cost	19,020
c) Office overheads	20,000
d) Inventory Capital	
TOTAL	$465,020

TABLE 32

7.2.3.1.8 - Operating Cost Estimate

Based on 8760 hrs/yr operation

100 Amp Scenario (Gasifier)

Direct Production Costs	
a) Fuel	
2500 tonnes Peat @ $29.50/tonne 50% M.C.W.B. 268,000 litres No. 6 fuel oil @ $.50 litre	$207,750
b) Operating Staff	
Four gasifier/engine operators @ 20,000/year	80,000
Four peat handlers (labourers) @ 8/hr	70,800
c) Expendable Materials Allowance	15,000
Diesel, hydraulic oil and fuel for mobile equipment	
d) Maintenance Allowance	2,500
(None of the North American gasifiers have operated for a long enough period to provide maintenance cost data.)	
Fixed Annual Costs	
a) Administration	
Plant Manager	30,000
Clerk Typist	14,000
Electrician	20,000
Mechanic	20,000
b) Insurance @ $6/1000 of capital cost	27,000
c) Office overheads	20,000
TOTAL	$507,050

TABLE 33

7.2.3.1.9 - Revenue Projections

1984 would not be an operating year, but the revenues are expressed in terms of 1984 electricity and peat demand volumes to keep them in perspective with the estimated capital and operating costs which are also in 1984 dollars. The electricity and peat for space heating revenues are claimed below, but the benefits accruing from the heating of a greenhouse have not been claimed.

100 Amp Scenario (Gasifier)

. 1984 Electricity Revenue per Section 7.2.1.4 (100 Amps)	$153,432
. Peat for space heating = 2125 tonnes x $48/tonne	102,000
Total Revenue	$255,432

20 Amp Scenario (Boiler)

. 1984 Electricity Revenue per Section 7.2.1.4 (20 Amps)	$ 98,836
. Peat for space heating = 2125 tonnes x $48/tonne	102,000
Total Revenue	$200,836

7.2.3.1.10 - Turndown and Growth Capabilities

a) There is not enough actual operating data available on a gasifier of this size to reliably record a turndown ratio.

b) Growth Capability

The system as outlined has a growth capability via plant expansion.

7.2.3.2 - Peat Fired Boiler and Steam Engine/Electrical Generator

7.2.3.2.1 - Peat Storage & Handling System Description

The fuel peat as required for the power plant and for space heating in the community will be delivered to a storage area adjacent the power plant. The peat, as noted earlier, will be supplied as "sod peat", that is in extruded cylindrical sections. It is intended that the peat remain on the bog for drying from solar heat. The "sods" will then be piled in racks or in some convenient container for ease of handling from bog to storage and from storage to point of use.

The peat will be handled in racks or preassembled containers by means of a fork lift vehicle. The containers will be piled 2 high, approximately 2 meters and covered with a plastic cover. Suitable drains will be provided around the storage area to insure that water does not accumulate at the base of the piles.

One operator will be required to oversee this receiving operation. The same man will be able to operate the pallet truck which will deliver the peat from the yard to the drying area. The peat harvesting operation will be confined to two (possibly three) months each year. The pallet truck entrance to the plant will be through a receiving vestibule. The outside plant entrance will be via an overhead equipment door which will be normally left open during loading operations. The vestibule interior wall will have a mobile equipment entrance door covered by an insulating ribbon curtain to retain drying space heat during the loading operation. Loading of the drying area will not be on a continuous basis. A short period once every day would be scheduled for loading the drying area with wet peat from the yard.

The drying area size allows for storage capacity equal to community and power station demand for 1 week. The required retention time in the drying area will be approximately seven days. This retention time will vary somewhat with the moisture content of the peat received in the yard. A moisture reduction of 10% will result in a 40% moisture content (wet basis) peat for use in the boiler and in the stoves throughout the community.

The peat racks will be stacked in rows with sufficient aisle space between rows to permit manoevering of a fork lift truck and to facilitate the circulation of warm air around the peat racks. The area will be heated by hot air distributed the length of the drying area by canvass air bags suspended from the ceiling. A large roof mounted air handling unit will be required in the centre of the drying area for air changes and makeup.

A forklift truck operator will deliver the palletized dry fuel to the boiler fuel receiving bin in the main plant area. This delivery will be required once every two hours. The same forklift vehicle and operator overseeing the wet peat loading into the drying area would be able to handle the dry peat delivery to the boiler.

The forklift truck operator unloading the palletized peat fuel will be assisted by the boiler operator. From this point on, the fuel delivery to the boiler will be completed automatically. Fuel in the receiving bin will be automatically conveyed to the hammermill, which will reduce the peat to 2" minus for use in the combustion chamber. A magnet in the feed chute over the hammermill will protect the mill and downstream equipment from tramp materials delivered with the wet harvested peat.

The hammermill will discharge to a day bin which will be equipped with a "low" level sensor and a "fill" level sensor. When the bin level drops to where there is room to accept a new 2 tonne rack of peat, a remote signal in the drying area will alert the forklift operator. If the operator does not respond and the bin level drops further to the "low" level condition, an alarm will be sounded to attract attention in the drying area and initiate boiler controls transfer to the oil backup system or initiate system shutdown. There will be a 15 minute grace period between the "fill" signal and sounding the "low" level alarm. This should be long enough to permit an operator to respond.

7.2.3.2.2 - Energy Conversion System

Figure 2 on the following page illustrates the proposed process flow.

(i) Generation of Steam

The dry peat will be metered out of the day bin in response to the "high" and "low" level signals on the metering bin over the stoker screw. The variable speed stoker screw will meter fuel directly into a combustion chamber in response to a signal proportional to steam demand from the boiler combustion control package.

The fuel is fed into the combustion chamber via an underfeed stoker which insures a tranquil feed with reduced risk of particulate carryover. The fuel burns in "pile" on the hearth with "underfire" and "overfire" air provided in the correct proportions for efficient combustion. The hot gases pass through the tubes of the steam generator and give up much of the heat to the water surrounding the tubes. It is planned to extract some additional heat from the exhaust gases through use of an economizer to recover heat for the boiler feed water.

The cooled gases, in the order of 150 to 175°C (300-350°F) will pass through the mechanical dust collector where ash and any carryover is extracted prior to entering the stack.

A forced draft (FD) fan provides combustion air. An induced draft (ID) fan maintains safe draft conditions within the combustion chamber.

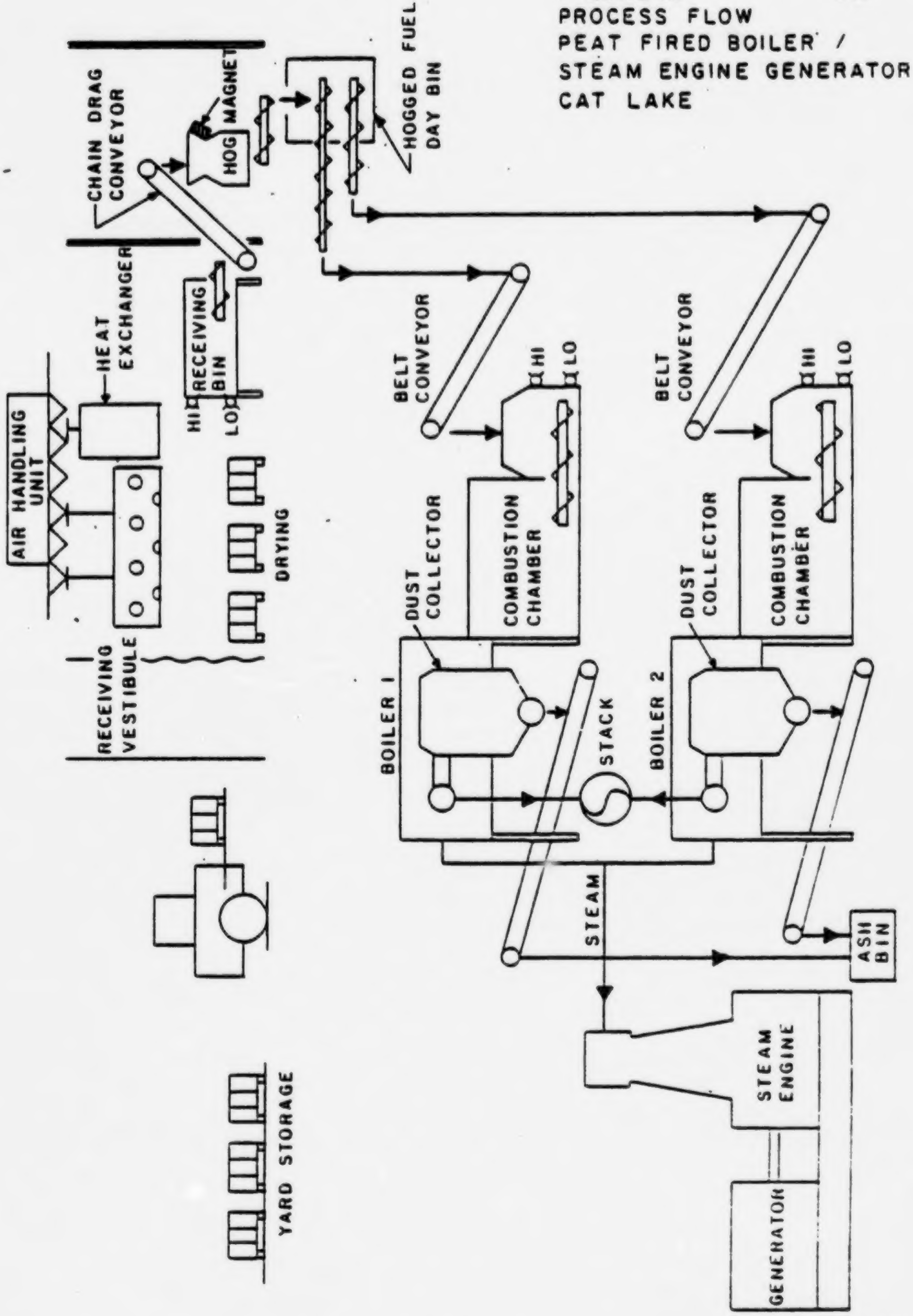
The ash is removed by screw from the combustion chamber and by means of a rotary valve from the dust collector. The ash and particulate is transported by screw conveyor or similar means to an ash container outside the plant.

The steam (saturated) is fed from the steam generator at 150 psig for use in the steam engine.

(ii) Conversion of Energy in Steam to Electric Power

The steam at 150 psig is passed through a steam engine consisting of a series of cylinders with steam extracted as back pressure at 15 psig for use in a greenhouse and for some drying of the peat. This back pressure concept provides a higher efficiency operation where some use can be given the exhaust steam. The power available from this type system ranges from 50 kW to 1500 kW and operates with steam

FIGURE 12
PROCESS FLOW
PEAT FIRED BOILER /
STEAM ENGINE GENERATOR
CAT LAKE


CHAIN DRAG CONVEYOR
HOG
MAGNET
HOGGED FUEL DAY BIN
HEAT EXCHANGER
RECEIVING BIN
HI
LO
AIR HANDLING UNIT
DRYING
RECEIVING VESTIBULE
BELT CONVEYOR
HI
LO
BELT CONVEYOR
HI
LO
DUST COLLECTOR
COMBUSTION CHAMBER
DUST COLLECTOR
COMBUSTION CHAMBER
BOILER 1
STACK
BOILER 2
STEAM
ASH BIN
STEAM ENGINE
GENERATOR
YARD STORAGE
ACI 2254

pressures from as low as 60 psig. The engine with its robust construction, conservative design combined with simplicity of operation make it an ideal selection for use in a remote community like Cat Lake.

The electrical generator is of the synchronous type - 3 phase, 60 hertz with generating voltage level of 600 volts or as may be required should power transmission distances dictate some higher level of voltage.

The plant would contain conventional auxiliaries such as water handling, water treatment, condensate handling, electric switching, control and instrumentation.

Provision is made in the estimate for facilities as required for the identified load plus 100% backup provided by a diesel fuel option on the engine generator.

7.2.3.2.3 - Technology Integrity

The combination of fire-tube boiler and the steam engine generator provides a simple design with relatively trouble-free components.

The fire-tube boiler design offers a maximum in flexibility with relatively low maintenance costs resulting from the limited use of refractory. The turn down for this type of unit is in the order of 3:1 to 4:1 which will meet the needs at Cat Lake. The boiler has capability for handling wet fuels up to 55 to 60% MC.

The steam engine utilizes the expansion of high pressure steam in the engine cylinders to produce a reciprocating motion which is transmitted to the direct connected electrical generator through a crankshaft connection. This concept was developed many years ago and has proven highly satisfactory due to its simplicity of operation and ease of servicing. It has in recent years largely been displaced by the lower cost but more complex steam turbine. Given that reliability of operation, low maintenance and ease of servicing are the major criteria, the steam engine concept is considered most suitable for the Cat Lake community.

7.2.3.2.4 - Heat Recovery

It is planned to recover heat from the following areas:

(1) the boiler exhaust gases

(2) the condensing of back pressure steam from the steam engine.

- It is proposed to include a heat exchanger in the hot gas stream leaving the boiler to transfer a portion of the heat in the gases, to feed water entering the boiler. The gas temperature leaving the boiler will be in the order of 290°C to 345°C (550 to 650°F), the temperature leaving the heat recovery unit will be maintained at about 150°C (300°F).

- The steam exhaust from the steam engine must be condensed before returning to the boiler. It is proposed to remove the exhaust at 15 psig which provides a useful heat source for the drying of peat as well as for a greenhouse.

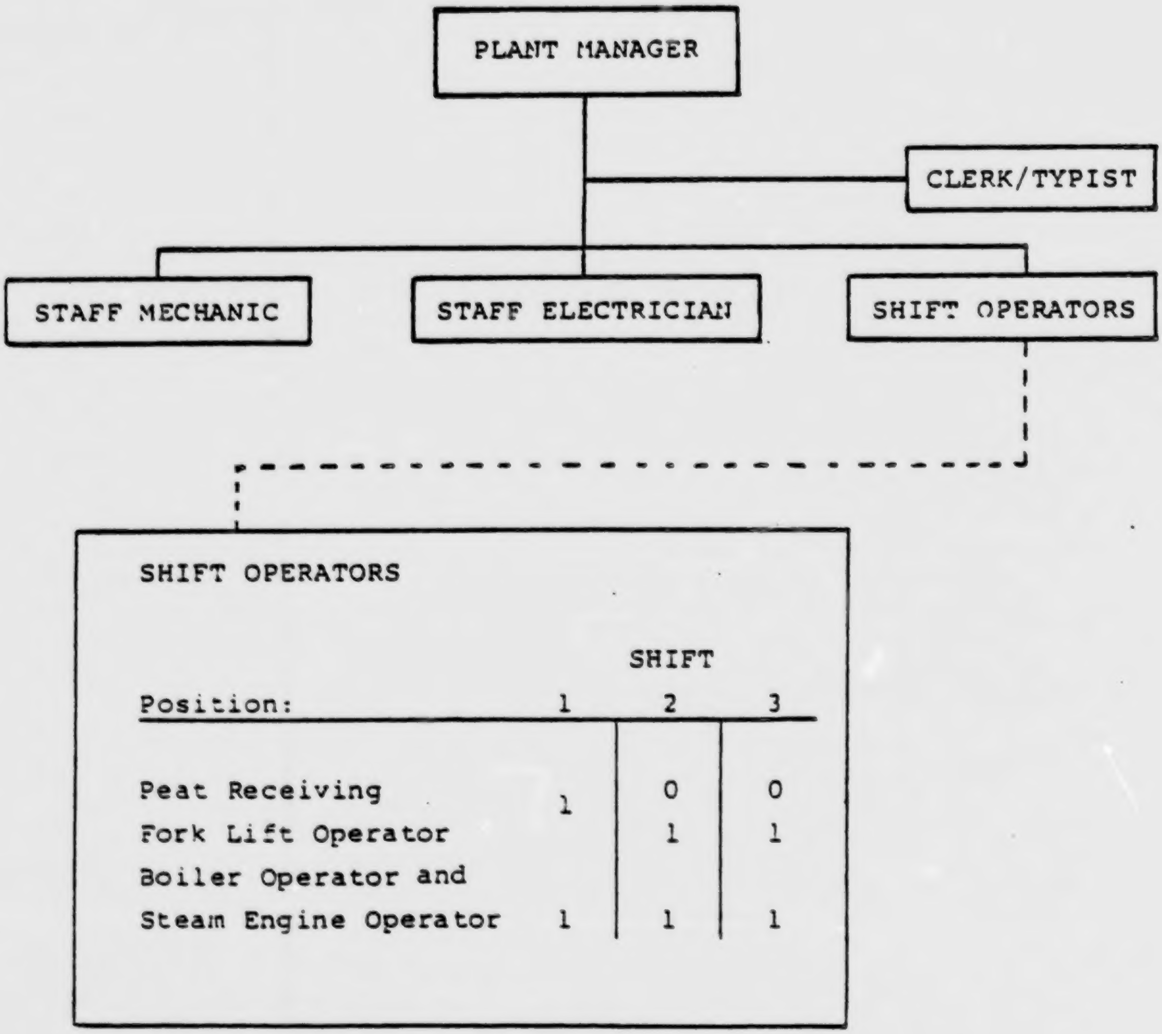
  It is intended to provide a surface condenser for operation during periods when the back pressure steam is not required.

7.2.3.2.5 - Flue Gas Emissions and Ash Residue

Provision is made in the gas stream for capture of particulate through the use of a mechanical type dust collector. This has proven to be satisfactory in similar solid fuel firing systems and with a relatively high stack, should provide emission levels to meet those stated in the current regulations. The gas contains only traces of sulphur. Contaminants from this source will be virtually non-existent.

The ash level may vary from 1% to as much as 10% of dry weight. Provision is made for a mechanized removal from the combustion chamber and from the dust collector. The ash would be transferred via screw conveyors to an ash container located outside the plant. The ash would be cooled with a water mist just before it is discharged to the ash container. The screw conveyors would be sealed and operate under a small vacuum to prevent dust discharge into the plant. The ash would be transported to some local disposal area using one of the peat handling vehicles.

7.2.3.2.6 Institutional Structure and Personnel Requirements


PLANT MANAGER
CLERK/TYPIST
STAFF MECHANIC
STAFF ELECTRICIAN
SHIFT OPERATORS

SHIFT OPERATORS

Position:	SHIFT 1	 2	 3
Peat Receiving	1	0	0
Fork Lift Operator		1	1
Boiler Operator and Steam Engine Operator	1	1	1

FIGURE 13

7.2.3.2.7 - Capital Cost Estimate
a) - 100 Amp Scenario

Account No.	Description	Budget
070	Site preparation	$ 225 000
080	Buildings and structures with Northern Construction Allowance	700 000
090	Mobile equipment	25 000
100	Fuel receiving	60 000
200	Peat handling equipment	88 000
300	Boilers and controls	360 000
400	Boiler auxiliaries	50 000
500	Steam engine generator set	200 000
600	Building services	60 000
700	Electrical	150 000
800	Maintenance shop	10 000
900	Office equipment	3 000
1000	Startup services	12 000
1100	Installation contracts plus Northern Construction allowance	210 000
1200	Spare parts	50 000
1300	Operator training programme	20 000
1400	Equipment transportation to Cat Lake from Thunder Bay	250 000
1500	Engineering & Contingencies	644 000
TOTAL		$3 116 000 *

* Federal & Provincial Sales Taxes are included

TABLE 34

070 - The figure carried for site preparation is only an allowance and will vary with actual site conditions. The work allowance is for site survey and soils investigation, excavation and rough grading, gravel and drainage, fire ponds, and finish grading and a fence around the peat receiving yard. There is no allowance for site access roads or landscaping.

080 - Building cost estimates are based on discussions with building contractors from Thunder Bay who have been involved with building metal buildings in Northern Ontario. The figures represent approximate costs of $75 per square foot for preengineered type metal buildings. The following assumptions were made in arriving at these costs:

1. all materials would be flown to the site.
2. construction of the airport at Cat Lake would be completed prior to construction of this project.
3. a relatively nearby source of gravel would be available for granular fill and concrete aggregate.
4. earthwork equipment used for airport construction would be available on a rental basis.

One other contractor in Thunder Bay was contacted and cautioned that if all materials and equipment had to be taken into Cat Lake from the south, then costs could escalate to $125/square foot in Cat Lake.

090 - Mobile Equipment
A single forklift truck will be sufficient to move wet peat racks from yard storage to the drying area, to load dry peat racks into the boiler receiving bins and to look after ash bin disposal.

100 - The fuel receiving equipment proposed will consist of diesel fuel oil storage tanks, a truck scale and a moisture analyzer.

200 - The peat handling equipment proposed includes the conveying and bin storage components. It is proposed to fabricate the equipment in Thunder Bay or some other center with as direct as possible shipping access to Cat Lake.

300 and 400 - The boilers and controls plus boiler auxiliaries, water treatment, a small deaerator and makeup water pumps will be purchased as a package. KMW and Volcano are two of the many possible suppliers.

500 - The price carried for the steam engine/generator set is for a Skinner "Unaflow" rebuild with a one-year parts and labour guarantee. This is the same guarantee as is carried on a new Skinner engine. The set is a complete package including inlet and exhaust separators, throttle valve and governor, gearbox and 500 kW 3 phase, 60 HZ, 600 VAC generator and controls. The generator has a diesel fuel backup system.

The base cost of the complete rebuild is US$131,247 FOB Erie, Pennsylvania. The base cost of a complete new unit is US$384,500 FOB Erie, Pennsylvania. The rebuild is available in 6-8 weeks after receipt of order. The delivery on a new unit is 6-8 months. The equipment is also available on a lease basis. Monthly leasing charges would be roughly 2% of the equipment capital cost. Skinner are preparing details of a leasing agreement and this document will be forthcoming.

600 - The building services allowance includes a sprinkler system, an air compressor, an air handling unit, some small unit heaters for employee offices and employee washroom fixtures.

700 - The electrical services cost covers building interior lighting and a small amount of exterior security floodlighting. A main electrical switchboard and motor control centers plus an operator console for the peat handling equipment is also included.

800 - The maintenance shop cost includes hand tools, a drill press, a hydraulic press and welding supplies.

900 - The office equipment cost includes files, desks, a typewriter, telex machine, calculator and a dozen hardhats.

1000 - Startup service costs are sufficient to include a boiler manufacturer representative, a steam engine/generator set manufacturer representative and the wood handling system designer representatives.

1100 - Both mechanical and electrical installation contracts are covered in this installation contracts figure.

1200 - Spare parts costs are allowed for at 5% of the total machinery costs.

1300 - The operator training programme would consist of a 5-day session.

1400 - The cost figure carried for equipment transportation allows for equipment delivery by air and winter road via Thunder Bay - Pickle Lake - Cat Lake. All equipment costs carried in the estimate are FOB Thunder Bay.

7.2.3.2.7 - Capital Cost Estimate
b) - 20 Amp Scenario

Account No.	Description	Budget
070	Site preparation	$ 225 000
080	Buildings and structures with Northern Construction Allowance	600 000
090	Mobile equipment	25 000
100	Fuel receiving	60 000
200	Peat handling equipment	88 000
300	Boilers and controls	300 000
400	Boiler auxiliaries	50 000
500	Steam engine generator set	100 000
600	Building services	60 000
700	Electrical	150 000
800	Maintenance shop	10 000
900	Office equipment	3 000
1000	Startup services	12 000
1100	Installation contracts plus Northern Construction allowance	210 000
1200	Spare parts	30 000
1300	Operator training programme	20 000
1400	Equipment transportation to Cat Lake from Thunder Bay	250 000
1500	Engineering & Contingencies	548 000
TOTAL		$2 741 000 *

* Federal & Provincial Sales Taxes are included

TABLE 35

7.2.3.2.8 - Operating Cost Estimate

Based on 8760 hrs/yr operation

100 Amp Scenario (Boiler)

Direct Production Costs	
a) Fuel	
4665 tonnes Peat @ $29.50/tonne 50% M.C.W.B.	$137,617
b) Operating Staff	
Four fourth class steam engineers @ $25,000/year	100,000
Four labourers, peat handling @ $8/hour	70,800
c) Expendable Materials Allowance	15,000
d) Maintenance Allowance	2,500
In actual compiled data of 21 engines from 2 to 10 cylinders the repair cost per engine per year averaged out to US $94.20. The calculations were made on engines in operation at least 4 years to a maximum of 13 years.[1]	
Fixed Annual Costs	
a) Administration	
Plant Manager (2nd class steam engineer)	35,000
Clerk/typist	14,000
Electrician	20,000
Mechanic	20,000
b) Insurance @ $6/1,000 of capital cost	18,700
c) Office overheads	20,000
TOTAL	$452,817

---

[1] Skinner Engine Company, May 16, 1984, Ron Misko

TABLE 36

7.2.3.2.8 - Operating Cost Estimate

Based on 8760 hrs/yr operation

20 Amp Scenario (Boiler)

Direct Production Costs	
a) Fuel	
2400 tonnes Peat @ $35/tonne 50% M.C.W.B.	$113,800
b) Operating Staff	
Four fourth class steam engineers @ 25,000/year	100,000
Four labourers, peat handling @ $8/hr	70,800
c) Expendable Materials Allowance	15,000
Diesel, hydraulic oil and fuel for mobile equipment	
d) Maintenance Allowance	2,500
In actual compiled data of 21 engines from 2 to 10 cylinders, the repair cost per engine per year averaged out to US $94.20. The calculations were made on engines in operation at least 4 years to a maximum of 13 years.[1]	
Fixed Annual Costs	
a) Administration	
Plant Manager (2nd class steam engineer)	35,000
Clerk/typist	14,000
Electrician	20,000
Mechanic	20,000
b) Insurance @ $6/1,000 of capital cost	16,440
c) Office overheads	20,000
TOTAL	$426,740

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[1] Skinner Engine Company, May 16, 1984, Ron Misko

TABLE 37

7.2.3.2.9 - Revenue Projections

1984 would not be an operating year, but the revenues are expressed in terms of 1984 electricity and peat demand volumes to keep them in perspective with the estimated capital and operating costs which are also in 1984 dollars. The electricity and peat for space heating revenues are claimed below, but the benefits accruing from the heating of a green house have not been claimed.

100 Amp Scenario (Boiler)

. 1984 Electricity Revenue per Section 7.2.1.4 (100 Amps)	$153,432
. Peat for space heating = 2125 tonnes x $48/tonne	102,000
Total Revenue	$255,432

20 Amp Scenario (Boiler)

. 1984 Electricity Revenue per Section 7.2.1.4 (20 Amps)	$ 98,836
. Peat for space heating = 2125 tonnes x $48/tonne	102,000
	$200,836

7.2.3.2.10 - Turndown and Growth Capabilities

The turndown ratio of peat-fired boiler is 5:1.

The system as outlined has growth capability via plant expansion.

7.2.4 Electrical Distribution System

7.2.4.1 Ontario Hydro Diesel Generated 20 Amp Service.

7.2.4.1.1 Extent of Service

The system as designed will supply power to the existing community from the Hudson's Bay facility on the East side of the village to the Western most residence and to the Airport on the North side.

7.2.4.1.2 Expansion Capability

The lines, distribution transformers and the substation have been designed and sized on the basis of Southern Ontario standards, which will allow all customers to expand to a 100 amp service.

Line sizing is based on good engineering practice and distribution feeders can be extended or branched to supply anticipated population expansion.

The capital cost is based on a five year phased installation of the distribution and service equipment required to meet the 1990 demand.

7.2.4.1.3 Personnel Requirements

Operating and maintenance personnel requirements are taken from the same 1982 Ontario Hydro report referenced in section 7.2.2.6. To quote them, "No major maintenance activities are expected during the first 10 - 15 years of operation.".

Area Forestry	Manhours/Site
Meeting with Band Council	
Make phone calls & finalize contract with Band Council	
Investigate and supervise contract work	
Follow-up on work inspected	
Paper work associated with contract	
Clearing and Brushing	170
Line Maintenance	
Maintenance for outages due to blown fuses, cracked insulators and other minor causes	72
TOTAL MANHOURS	242

7.2.4.1.4 Capital Cost Estimate

The distribution system capital cost estimate is based on the system described in Section 7.2.2.2 and takes into account the same assumptions covered in Section 7.2.2.5, with the exception that the initial construction period extends from 1985 to 1990 and the final construction from 1990 to 2000. The 1984 estimate shown below assumes that 75% of this money will be used in the first two years and the year 2000 costs are spread evenly over the years between 1990 and 2000.

Account No.	Description	Budget	
		1984 Cost	2000 Cost
300	Substation	$28,540	
400	Distribution System	326,417	$100,000
	- H.V. wire		
	- L.V. wire		
	- Poles		
	- Pole Supports		
	- Meters		
	- Transformers		
	- Installation		
1150	Band Labour	37,130	
1500	Engineering & Contingency	97,913	
TOTALS		$490,000	$100,000

TABLE 38

7.2.4.1.5 Operating Cost Estimate

Personnel

The following operating costs for personnel have been developed using the manhour estimates in Section 7.2.4.1.4

Work Item	Manhours	Cost
Area Forestry	170	$3,700
Line Maintenance	72	3,400
TOTAL	242	$7,100

TABLE 39

Traveling and Living Expenses

One hundred hours of the above time is local labour for which there is no travel required and only 50% of the remainder requires onsite work by an outsider. It has been assumed that all work done by someone flying in will be on a daily basis which would necessitate seven trips per year at a total cost of $1,000

Parts and Materials

Parts and materials have been estimated at 20% of the labour cost. This equates to $7,100 x .2 = $1,420

Total Operating Cost

Item	Cost
Personnel	$7,100
Travel & Living	1,000
Parts & Materials	1,420
TOTAL	$9,520

TABLE 40

7.2.4.2 Peat Generated 20 Amp Service

The distribution system for this option will be similar to that for the diesel option described above except for the initial 1984 capital cost.

The proposed location of the peat generation facility is one kilometer further from the village than the diesel system and therefore an additional kilometer of high voltage line would be required at a cost of $20,000

7.2.4.3 Peat Generated 100 Amp Service

The distribution line requirements for 100 amp services are covered by the same system designed for the 20 amp services. However, to meet the year 1990 100 amp requirements, an additional 750 kva transformer would have to be added to the substation at a cost of $23,540.

8.0 Social and Environmental Concerns

8.1 General

This report provides a state-of-the-art review of expected social impacts and the composition and diversity of fish and wildlife in peatland areas. Impacts of peatland development on aquatic and terrestrial ecosystems are examined and alternatives for impact mitigation, reclamation and peatland conversion are suggested.

Where available information allows, predictions of impacts specific to the Cat Lake are made along with recommendations for mitigation or further research needed. Information for this study was complied through manual and computerized literature searches of published and unpublished documents, and personal contacts with public and private agencies and individuals.

8.2 Social, Cultural and Economic Issues

Since details as to the size of the development, infrastructural alternatives, construction labour, site location, operation, and management of the peat mine and power production are yet to be finalized, the following issues are generic in nature and developed through past experience with impacts of mining operations on Native Peoples in other remote locations and the general analysis conducted by the Royal Commission on the Northern Environment (Bishop, 1974; Driber, no date; Royal Commission on the Northern Environment, 1979).

Socio-economic and cultural impacts will depend largely on the number and management of outside workers during the construction and early operational stages. Studies at Osnaburg by Eedy and Bishop following opening of the Pickel Lake mines indicated a wide range of problems, including:

- interactions with miners and the community,
- cultural problems in coping with regular, shift working schedules,
- increased alcohol and drug problems,
- discrimination and fighting; and
- problems in managing earnings.

In addition to the potential detrimental impacts, the development will result in a number of benefits to the Band, such as;

- opportunities for employment and wages,
- opportunities for use of modern electrical facilities,
- improved heating; and
- on-job training.

Resource use impacts can be extremely impartant to a Band which relies on subsistence living. Four resources are seen as most critical at Cat Lake;

- **Fisheries** - The Band operates both domestic and commercial fisheries. Many of the species, such as pickerel and pike spawn in either stream outlets or bays which could be affected by equipment operation or bog drainage.
- **Furbearers** - Traplines and species could be directly impacted upon by peat excavation or disturbances by equipment and workers.
- **Wildlife** - Species such as caribou, moose and waterfowl, hunted by the Band could be disturbed through construction activities and habitat loss.
- **Water** - Bog drainage could affect drinking water supplies.

The Health and Safety of Band members is a critical consideration. Air and water quality are both important to health protection. Trucks and heavy equipment as well as presence of the power plant could result in safety problems.

Mitigation recommendations and areas of research needs are outlined on following page.

8.3 Generic Impact Evaluation

At a preliminary feasibility stage, not enough design information is available to accurately assess all site-specific impacts. The following discusses generic impacts relevant to any peat extraction and burning project in northern Ontario. This is based on literature reviews by Clarke-Whistler and Rowsell (1982); Clarke-Whistler, Rowsell and Lush (1983); Midwest Research Institute (1978), and a pilot study in Newfoundland (Osborne, 1982).

Clarke-Whistler and Rowsell (1982) indicate that peatlands generally have a low productivity. However, there are a number of birds and mammals for which peatlands are seasonally important or critical habitat. Excavation of this habitat would impact significantly on these species. They further indicate that although the diversity and abundance of fish in peatlands are low, important species are often found in the drainage systems which could be impacted upon through chemical or hydrological changes induced by development. Amphibian and reptile species are usually not significant in peatlands.

Clarke-Whistler and Rowsell (1982) report the following as the most important impacts relevant to peatland:

<ins>Aquatic</ins>

- hydrological impacts of drainage and ponding
- release of nutrients, humic substances and trace metals
- reductions in light, pH and oxygen
- increase suspended solids and sedimentation
- species impacts downstream

IMPACT POTENTIAL	MITIGATION RECOMMENDATION	RESEARCH NEEDS
• interaction with outside labour	• maximize Band jobs • lengthen development period through lower labour force • use labour from nearby Bands • prohibit alcohol from construction camp • isolate construction camp from Band • provide training in money management • maximize on job training potential	• Band skils • labour requirements • Band desires
• Fisheries	• control siltation, vehicle operation and chemicals • avoid drainage into spawning areas	• to locate significant spawning sites • to determine species of local importance
• Furbearers	• compensation	• trapper use of peat area
• Wildlife	• avoide equipment operation in critical habitats during critical seasons • prohibit hunting by outside labour	• to locate critical habitats and seasonal use by caribou, moose, and waterfowl
• Water	• avoid drainage into used areas	• chemical analysis of peat water • dispersion and dilution analysis
• Health and Safety	• proper treatment of emissions and effluents • Safety measures on equipment	• emission and effluent data, ambient meteorological data, modelling

GENERIC IMPACT EVALUATION
TABLE 41

Terrestrial

- habitate loss
- impacts of access roads, noise and human disturbances

Reclamation

- productivity often increases

Osborne (1982) reported initial results of the High Point Bog drainage pilot plant in Newfoundland. Most water quality parameters were not significantly changed between upstream and downstream stations. Leaching of heavy metals did not seem to be a problem. In a similar type of study, based on long-term laboratory simulation of peatland flooding and computer modelling, Schiefer and Eedy (1977) reported that concentrations of colour, total phosphate and total nitrogen were substantially increased, while acidity and BODs did not change significantly. Toxicity tests with both trout and invertebrate species indicated the absence of acutely toxic substances in the peat exposed water.

Osborne (1982) summarized the more significant potential impacts of peat development as:

Drainage

- lowering of regional water table
- downstream acidity
- loss of hydraulic reservoir action

Burning

- fly ash
- release of heavy metals from their organometal complexing
- residual ash disposal

Clarke-Whistler, Rowsell and Lush (1983) indicate peatlands are important habitats for a number of birds or mammals which are reportedly of some significance in the Cat Lake area on either a year round or seasonal basis:

- Snowshoe Hare,
- American Beaver,
- Lynx,
- American Marten,
- Moose,
- Caribou, and
- Waterfowl.

The types of impacts they predict would result from peat development include:

- Habitat loss,
- Erosion,
- Increased surface runoff,
- Lowered water table,
- Chemical changes in local waters and soils,
- Increased fire hazard, and
- Increased human access.

8.4 Site Specific Impacts

The Level II matrix presented in the following Figure provides a best estimate of site specific impacts based on the data available. The key impact areas for which further studies are recommended include:

Water

- Trace element and pH impacts into Cat Lake and Little Cat Lake River,
- Groundwater and surficial hydrology, impacts due to drainage, and
- Fisheries impacts, especially related to pike or walleye spawning areas.

Land

- Use of extraction areas by caribou and moose,
- Bald eagle nesting in area, and
- Habitat loss due to project components.

Air

- Emission and meteorological data will be required to model ground level impingement of trace elements (human health) and dioxide (vegetation).

Resource Use

- Fisheries areas,
- Traplines,
- Hunting areas, and
- Drinking water supply locations.

8.5 Mitigation of Environmental Impacts

The incorporation of environmental considerations at the development planning stage is the most effective and cost efficient method of impact mitigation. Preliminary surveys to collect baseline information concerning fish and wildlife diversity and abundance, critical habitats and ecological interactions can be conducted coincidentally with geotechnical and engineering surveys. Areas found to contain rare or sensitive species and critical or unique habitat should not be developed.

Once a suitable site has been selected construction activities can be planned for maximal localization of adverse impacts. Access roads should cross ecotones and watercourses at right angles, and should allow for adequate cross-drainage. Avoidance of steep grades will minimize erosion potential. Cleared road width should be kept to a minimum and roadside vegetation should not be maintained where rivers or streams run parallel to roads. Likewise, powerlines should be placed so as to avoid water bodies. Towers should be of minimal height to minimize impacts to birds.

Site preparation and the construction of service facilities will have minimal impact on wildlife and water quality if carried out during the winter months. Natural buffer zones around and within cleared sites and drainage channels protect vegetational genetic diversity, provide wildlife habitat, decrease erosion and attentuate water resource impacts. Cleared vegetation should be disposed of to reduce fire hazards and permit wildlife movement.

LEVEL II MATRIX

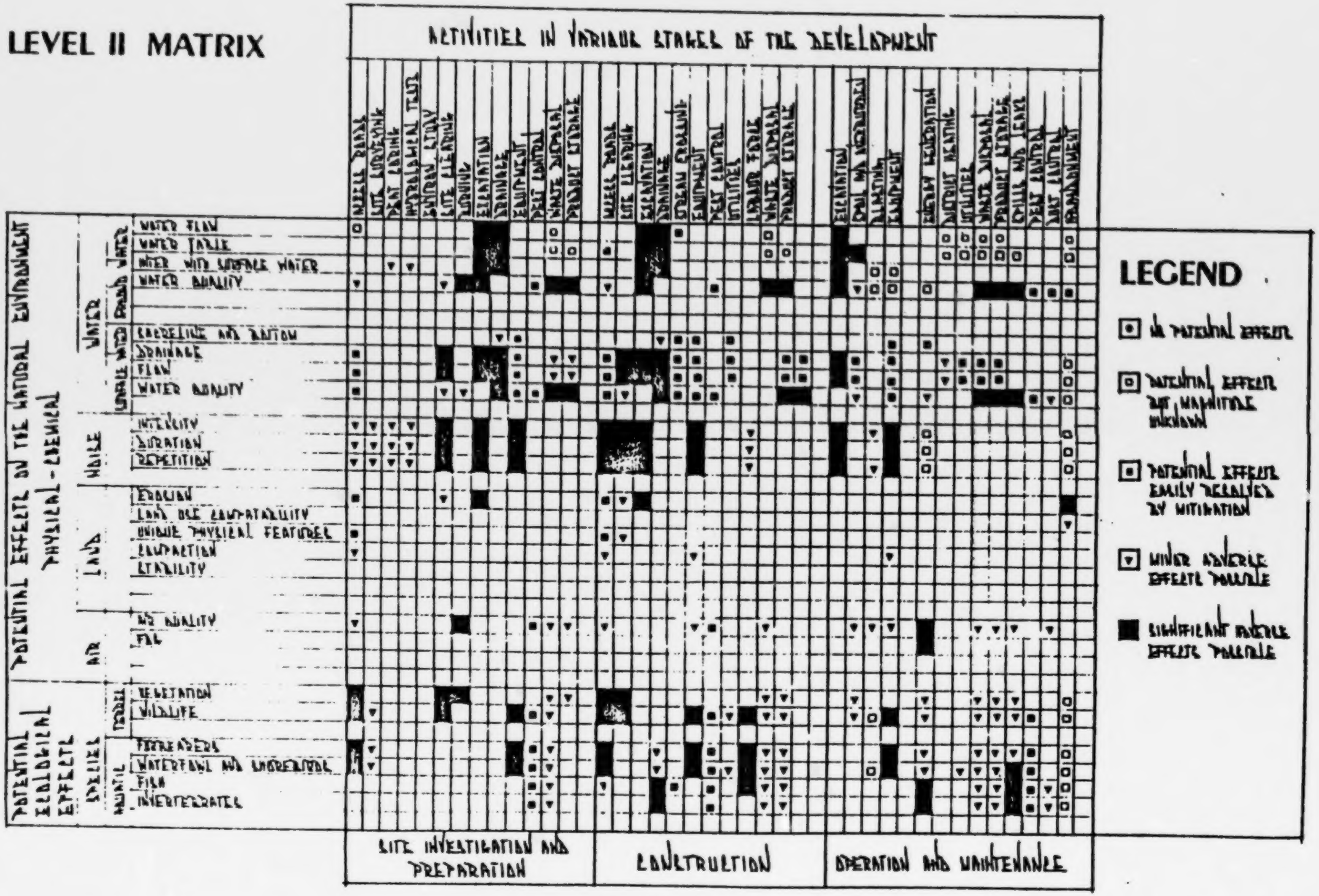

ACTIVITIES IN VARIOUS STAGES OF THE DEVELOPMENT
ACCESS ROADS
SITE SURVEYING
TEST BORING
HYDROLOGICAL TESTS
BASELINE STUDY
SITE CLEARING
LOGGING
EXCAVATION
DRAINAGE
EQUIPMENT
PEST CONTROL
WASTE DISPOSAL
PRODUCT STORAGE
ACCESS ROADS
SITE CLEARING
EXCAVATION
DRAINAGE
STREAM CROSSING
EQUIPMENT
PEST CONTROL
UTILITIES
LABOUR FORCE
WASTE DISPOSAL
PRODUCT STORAGE
EXCAVATION
COAL AND OVERBURDEN
BLASTING
EQUIPMENT
ENERGY GENERATION
OUTDOOR HEATING
UTILITIES
WASTE DISPOSAL
PRODUCT STORAGE
SPILLS AND LEAKS
PEST CONTROL
DUST CONTROL
ABANDONMENT
POTENTIAL EFFECTS ON THE NATURAL ENVIRONMENT
PHYSICAL - CHEMICAL
WATER
GROUND WATER
WATER FLOW
WATER TABLE
INTER. WITH SURFACE WATER
WATER QUALITY
SURFACE WATER
SHORELINE AND BOTTOM
DRAINAGE
FLOW
WATER QUALITY
NOISE
INTENSITY
DURATION
REPETITION
LAND
EROSION
LAND USE COMPATIBILITY
UNIQUE PHYSICAL FEATURES
COMPACTION
STABILITY
AIR
AIR QUALITY
FOG
POTENTIAL ECOLOGICAL EFFECTS
SPECIES
TERREST.
VEGETATION
WILDLIFE
AQUATIC
WATERFOWL AND SHOREBIRDS
FISH
INVERTEBRATES
SITE INVESTIGATION AND PREPARATION
CONSTRUCTION
OPERATION AND MAINTENANCE
LEGEND
NO POTENTIAL EFFECT
POTENTIAL EFFECT BUT MAGNITUDE UNKNOWN
POTENTIAL EFFECTS EASILY RESOLVED BY MITIGATION
MINOR ADVERSE EFFECTS POSSIBLE
SIGNIFICANT ADVERSE EFFECTS POSSIBLE

FIGURE 14

The most effective methods of mitigating water resource impacts utilize natural processes. The natural filtering capacity of peat can be used to remove nutrients and metals if blind-ended drainage channels are constructed. This method also controls the interchange of water within the developed peatland and surrounding areas. A Series of settling ponds may be constructed if direct drainage into watercourses is necessary. Alternatively, artifical methods such as cut-off walls, berms, dikes and re-routing of surface waters may be employed; vertical and horizontal water movement can be controlled through the use of materials with differing permeabilities.

Methods of controlling pH include mixing with natural upwellings from near-surface aquifers, or passing discharge waters through in situ soils, as described above. Addition of lime may be desirable in large-scale operations.

The following types of generic mitigation for development in peatlands are recommended:

- Minimize access road clearance,
- Avoid use of pesticides,
- Maintain buffers between roads and watercourses,
- Settling ponds on drainage channels, and
- Reclamation maintenance of soil saturation and re-establishment of heterogeneous vegetation cover.

9.0 Economic Analysis

9.1 Introduction

The analysis of the various scenarios and technical options is quite complicated with interrelated factors including the following:

- Technical diversity
- Currently evolving gasifier technology
- Current multiple sources of funding to the community
- Social benefits expressed in terms of improved living standards and increased employment.

Section 9.0 of the report expresses the financial implications of the potential projects in various ways so that these quantifiable factors can be compared to the less tangible considerations in the following Section 10.

9.2 Basis of Evaluation

The options will be financially evaluated on the basis of a single government body responsible for providing, maintaining and operating each complete facility. (This assumption does not preclude the possibility of a second group being designated as an "agent" to operate all or a part of a system). The construction and operation of the alternative facilities can then be assessed in accordance with several financial criteria as follows:

- Life cycle costing basis with the annual Net Operating Margins discounted to 1984 dollars which is the basis for the Total Capital estimates. The resulting Net Present Values (NPV) for each option can then be compared to give a relative indication of project performance.
- The conventional Ontario Hydro Diesel Generator facility for northern communities is used as the basis for comparing options. The 1984 electrical selling prices for this type of facility are used for calculating revenues on all options.
- The cost per kWh has been calculated for each option to provide a second method of comparison.
- A table based on the calculated cost per kWh shows the average cost per household for each option and the ratio of that cost to the datum Diesel Generator system.

9.3 Analysis Data and Assumptions

9.3.1 Data Sources

System Costs

The costs for all options were developed in Section 7.0 on the basis of the northern Cat Lake location. The specific references are as follows:

- Grid Connection – Capital Cost – Section 7.2.1.2
  Operating Cost – Section 7.2.1.3
- Diesel Generator Plant – Capital Cost – Section 7.2.2.5
  – Operating Cost – Section 7.2.2.7
- Peat Fired Gasifier and Gas Operated Engine/Generator – Capital Cost – Section 7.2.3.1.7
  – Operating Cost – Section 7.2.3.1.8
- Peat Fired Boiler and Steam Engine/Generator – Capital Cost – Section 7.2.3.2.7
  – Operating Cost – Section 7.2.3.2.7

System Revenues

The basis for revenue projections were developed in Section 7.0 with specific references as follows:

- Grid Connection – Section 7.2.1.4
- Diesel Generator Plant – Section 7.2.2.8
- Peat Fired Gasifier and Gas Operated Engine/Generator – Section 7.2.3.1.9
- Peat Fired Boiler and Steam Engine/Generator – Section 7.2.3.2.9

Delivered Peat Costs

Delivered peat costs were developed in Section 5.5.3

Inflation Factors

The latest Ontario Ministry of Energy inflation projections, per Appendix H, have been used with the IFPS program. The application of these inflators is in accordance with the following:

- **Electricity Revenues per Electricity Inflator for the grid connection option and the Fossil Fuel Inflator for all other options.**
- **Peat Revenue from Space Heating per Fossil Fuel Inflator**
- **Harvested Peat Cost per Labour Inflator**
- **Personnel Operating Costs per Labour Inflator**
- **Miscellaneous Materials per General Price Inflator**
- **Insurance at 5% per year**

9.3.2 Assumptions

The basis for various project assumptions are as follows:

Capitalization

100% public sector (government) equity

Project Life

The proposed equipment and electrical distribution facility should represent a 20 year life, but as an act of conservatism, 15 years has been used for the analysis.

Schedule

Due to the multiple Federal and Provincial government parties involved with the project decision making, the system operation has been conservatively set for the beginning of 1988. Thus, the IFPS printouts will show a "construction" period as the years 1985, 1986 and 1987 and the project life extending from 1988 to 2003 inclusive. Detailed financial performance is shown for the project milestone years of 1990 and 2000.

Community Energy Growth

Housing growth was developed in Appendix 'B' so that the residential energy need projections are simple extensions of the housing inventory each year and the unit energy consumption rates developed for space heating and electrical consumption. The community building program projected by Marshall Macklin Monaghan Limited in the 1984 "Cat Lake Indian Reserve Community Planning and Housing

Infrastructure Servicing Feasibility Study" was not broken down on an annual basis. Thus, the growth by year for the computer runs has been based on linear growth between the milestone years. The conversion of facilities to peat space heating has been staggered from the quantities shown in Section 4.0 to demonstrate a more gradual acceptance of the benefits accruing from this new space heating resource.

Discount Rate

The life cycle costing provided by the IFPS program requires a discount rate to facilitate the conversion of future cash flows (Revenues and Expenses) to current 1984 dollars. This allows the stream of future flows to be algebraically added to the total capital which is also expressed in 1984 dollars. Based on advice from EMR a discount rate of 15% has been used to in effect cover the real discount and inflation factor.

Interest Rate

For public sector investments the IFPS program determines Net Present Value on the basis of total capital and the flow of operating margins. Thus, interest rates for construction financing and long term debt are not required.

Capital Cost Allowances

Accelerated Class 34 Capital Cost Allowances would be applicable for this class of facility, but are not pertinent in this instance since the private sector is not financing the project.

Taxes

The cost estimates include 10% and 7% Federal and Provincial Sales Taxes respectively where applicable. Due to the public ownership Corporate Taxes are not calculated by the program.

Peat For Space Heating Revenues

In accordance with advice from Jack Carroll, of DIAND, in Sioux Lookout, the value of peat for residential space heating has been set at the equivalent of $70 per cord of wood. This charge basically represents the costs to cut and transport the wood for space heating. Using the conversion factors established in Section 4.3.1 this equates to $48/tonne of 40% moisture peat.

Without the benefit of reasonably priced electricity or peat most of the future community buildings would be heated by oil to provide uniformity of comfort. Using the Section 4.3.1 figure for usable heat of 23.21 MJ/litre of No.2 fuel oil and a peat furnace efficiency of 50% the value of peat expressed in terms of the displaced oil is $143/tonne. However, the very conservative cost of $48/tonne, which was identified for private residences, has been used in the financial analysis for community buildings. The cost of stoker fed peat furnaces would be included with the community building costing in the normal way just as the oil furnaces would be otherwise included.

9.4 Ontario Hydro Grid Connection

9.4.1 20 Amp Scenario

The Cat Lake community would not meet the customer requisites for a grid connection by Ontario Hydro. However, it is still pertinent to use this option for comparing with other options. The complete computer printout is in Appendix H and an abbreviated summary is as follows:

TABLE 42

Item	**1990**	**2000**	**15 Year Life (1988-2003)**
Project Construction Cost			$6,237,000
Revenue - Electricity	$270,000	$801,000	
Peat for Space Heating	---	---	
Total Revenue	$270,000	$801,000	
Operating Costs	111,000	276,000	
Net Operating Margin	$159,000	$525,000	
Net Present Value(NPV) (Net Operating Margin to Total Capital)			$(3,615,000)
IRR (Net Operating Margin to Total Capital)			<0
Annual Income to Community	$0	$0	

The project has a negative NPV of $3,615,000 when future cash flows are discounted at 15%. The NPV would still be negative at a zero discount rate.

Note: It should be noted from the above summary and for those that follow that computer rounding sometimes creates number sets which do not balance. In those cases a value has been "rounded" to present mathematically correct numbers within the text.

9.4.2 100 Amp Scenario

The 100 Amp grid connection scenario would not meet the normal Ontario Hydro customer criteria and thus they would not provide this form of service on their own. However, it still is useful to compare this means of delivering electricity with those options which involve local power generation. The economic summary is as follows:

TABLE 43

Item	**1990**	**2000**	**15 Year Life (1988-2003)**
Project Construction Cost			$6,237,000
Revenue - Electricity	$546,000	$1,625,000	
Peat for Space Heating	---	---	
Total Revenue	$546,000	$1,625,000	
Operating Costs	194,000	484,000	
Net Operating Margin	$352,000	$1,141,000	
Net Present Value(NPV) (Net Operating Margin to Total Capital)			$(2,637,000)
IRR (Net Operating Margin to Total Capital)			5%
Annual Income to Community	$0	$0	

The project has a negative NPV of $2,637,000 when discounted at 15%. If the discount rate was reduced to 5% (IRR) the NPV would be zero.

~~9.3~~ Ontario Hydro Diesel Generator Plant

This option represents the standard facility that is normally provided for remote northern communities. Thus, it is what the peat options should be compared with in the analysis. Residential connections are normally fused for a maximum load of 20 Amps while community buildings are provided with 100 Amp service. A diesel generator scenario providing 100 Amp service to houses has not been considered. The economic summary is as follows:

The project has a negative NPV of $2,182,000 when discounted at 15% and would still be negative at 0% discount rate. It is significant to note that at the year 2000 the Net Operating Margin is significantly negative at $559,000 and this deficit grows annually.

TABLE 44

Item	**1990**	**2000**	**15 Year Life (1988-2003)**
Project Construction Cost			$1,518,000
Revenue - Electricity	$270,000	$801,000	
Peat for Space Heating	---	---	
Total Revenue	$270,000	$801,000	
Operating Costs	518,000	1,360,000	
Net Operating Margin	($248,000)	($559,000)	
Net Present Value(NPV) (Net Operating Margin to Total Capital)			($2,182,000)
IRR (Net Operating Margin to Total Capital)			<0
Annual Income to Community	Almost 0	Almost 0	

9.6 Peat Fired Gasifier and Gas Operated Engine/Generator

9.6.1 20 Amp Scenario

This is the first of four technical option/Amp Scenario combinations utilizing the indigenous peat resource. The economic summary is as follows:

The NPV of negative $4,476,000 results form a discount rate of 15% and would still be negative at 0% discount rate. The Net Operating Margin is a significant negative $578,000 in the year 2000 and this negative cash flow continues to grow. Relative to the 100 Amp Gasifier package which follows this system costs less to install and represents a lower cost to the owner over the 15 year life of the project. The annual income to the community in the year 2000 would be a significant $951,000.

TABLE 45

Item	**1990**	**2000**	**15 Year Life (1988-2003)**
Project Construction Cost			$4,398,000
Revenue - Electricity	$270,000	$415,000	
Peat for Space Heating	184,000	801,000	
Total Revenue	$454,000	$1,216,000	
Operating Costs	787,000	1,794,000	
Net Operating Margin	($333,000)	($578,000)	
Net Present Value(NPV) (Net Operating Margin to Total Capital)			($4,476,000)
IRR (Net Operating Margin to Total Capital)			<0
Annual Income to Community	$460,000*	$951,000*	

* Approximately 86% of the item that has been lumped together covering operating labour, supervisory labour and maintenance materials represent income that stays in the community. 50% of the peat feedstock cost also represents community income.

9.6.2 100 Amp Scenario

This is similar to the previous peat utilization option with the exception that it is based on higher residential electrical consumption. The economic summary is as follows:

Over the 15 year life of the operating system, the NPV is negative $5,918,000 when discounted at 15%. The NPV would still be negative at 0% discount rate. The Net Operating Margin is a significant negative $501,000 in the year 2000 and the negative cash flow continues to grow. The one positive element of this particular system relative to the Ontario Hydro possibilities is that the annual income flowing into the community in the year 2000 equals $1,017,000.

TABLE 46

Item	**1990**	**2000**	**15 Year Life (1988–2003)**
Project Construction Cost			$6,523,000
Revenue - Electricity	$546,000	$1,626,000	
Peat for Space Heating	184,000	414,000	
Total Revenue	$ 730,000	$2,040,000	
Operating Costs	1,054,000	2,541,000	
Net Operating Margin	($324,000)	($501,000)	
Net Present Value(NPV) (Net Operating Margin to Total Capital)			($5,918,000)
IRR (Net Operating Margin to Total Capital)			<0
Annual Income to Community	$490,000	$1,017,000	

Peat Fired Boiler and Steam Engine/Electrical Generator

9.7.1 20 Amp Scenario

This is the first of two peat options which use the well established technology of peat burned in a boiler to produce steam which, through a steam engine and generator, produces electricity. The economic summary is as follows:

Except for the initial capital expenditure being less, this package does not have as good financial performance as the following larger boiler system that provides 100 Amp service. The Net Operating Margin remains nearly constant throughout the project at approximately negative $250,000 per year and the NPV over the project life is a negative $3,642,000. The annual income into the community is quite attractive at $515,000 and $1,072,000 for the years 1990 and 2000 respectively.

TABLE 47

Item	**1990**	**2000**	**15 Year Life (1988-2003)**
Project Construction Cost			$3,883,000
Revenue - Electricity	$270,000	$ 801,000	
Peat for Space Heating	184,000	415,000	
Total Revenue	$ 454,000	$1,216,000	
Operating Costs	698,000	1,476,000	
Net Operating Margin	($244,000)	($260,000)	
Net Present Value(NPV) (Net Operating Margin to Total Capital)			($3,642,000)
IRR (Net Operating Margin to Total Capital)			<0
Annual Income to Community	$515,000	$1,072,000	

100 Amp Scenario

The economic summary is as follows:

The financial performance of this package is substantially better than the 100 Amp Gasifier system. The initial capital investment is $2,189,000 less and the NPV over the life of the project is $3,050,000 better. The Net Operating Margin is also superior in that it is close to a breakeven situation in 1990 at negative $27,000 and is a positive $461,000 in 2000 versus a negative $501,000 for the Gasifier. The annual income to the community is a very desirable $543,000 and $1,121,000 for the years 1990 and 2000 respectively.

TABLE 48

Item	**1990**	**2000**	**15 Year Life (1988-2003)**
Project Construction Cost			$4,334,000
Revenue - Electricity	$546,000	$1,626,000	
Peat for Space Heating	184,000	414,000	
Total Revenue	$730,000	$2,040,000	
Operating Costs	757,000	1,579,000	
Net Operating Margin	($ 27,000)	$ 461,000	
Net Present Value(NPV) (Net Operating Margin to Total Capital)			($2,868,000)
IRR (Net Operating Margin to Total Capital)			<0
Annual Income to Community	$543,000	$1,121,000	

9.8 Economic Summary

.1 Introduction

The economic summary sheet which follows provides the basis for the comments in this Section. The question of 20 Amp versus 100 Amp service could ultimately be settled by considering the relative costs, but it must also be considered in terms of social value with respect to better living standards. Thus, in this Section, the results are interpreted separately for 20 Amp and 100 Amp scenarios so that they can be combined with social factors in the Section 10 Conclusion. It should be noted that in order to provide as objective as possible an evaluation it has been agreed that options would be evaluated as if a single organization was responsible for the complete exercise of providing community services and operating them.

TABLE 49

ECONOMIC SUMMARY OF TECHNICAL OPTION/AMP SCENARIO SYSTEMS

	GRID		**DIESEL GENERATOR**	**GASIFIER**		**STEAM ENGINE**	
	20 Amp	100 Amp	20 Amp	20 Amp	100 Amp	20 Amp	100 Amp
Construction Cost ($'000)	6,237	6,237	1,518	4,398	6,523	3,883	4,334
Net Present Value (NPV) ($'000)	(3,615)	(2,637)	(2,182)	(4,476)	(5,918)	(3,642)	(2,868)
Community Income - Year 2000 ($'000)	0	0	0	951	1,017	1,072	1,121
Net Operating Margin ($'000)							
- 1990	159	352	(248)	(333)	(.324)	(244)	(27)
- 2000	525	1,141	(559)	(578)	(501)	(260)	461
Annual kWh ('000)							
- 1990	856	2,036	856	856	2,036	856	2,036
- 2000	1,151	2,747	1,151	1,151	2,747	1,151	2,747
Average Cost/kWh ('000)							
- 1990	.11	.09	.61	.70	.43	.60	.28
- 2000	.21	.17	1.18	1.20	.77	.92	.42
Ratio of Cost/kWh to Diesel Generator "Standard" System							
- 1990	.18	.15	1.0	1.15	.70	.98	.46
- 2000	.18	.14	1.0	1.02	.65	.78	.36

9.8.2 20 Amp Scenario

The Diesel Generator option represents the standard service to remote northern communities with 20 Amp fused connections to private residences and 100 Amp services for community buildings. The capital costs for this type of system are normally paid for by DIAND with Ontario Hydro assuming responsibility for operations and the option has been costed accordingly.

All options result in a negative NPV over the 15 year project life because of the small number of consumers on the system. The life cycle costs in descending order are as follows:

Option	**Net Present Value**
. Diesel Generator	($2,182,000)
. Grid Connection	($3,615,000)
. Steam Engine	($3,642,000)
. Gasifier	($4,476,000)

With respect to ranking the two peat utilization options for life cycle costing, the steam engine is superior to the gasifier. The Diesel Generator option represents the best option for the 20 Amp Scenario when assessed on the basis of NPV only.

The average cost per kWh delivered to the community consumers is as follows:

Option	**Average Cost Per kWh($/kWh)**	
	1990	2000
. Grid Connection	.11	.21
. Steam Engine	.60	.92
. Diesel Generator	.61	1.18
. Gasifier	.70	1.20

The Ontario Hydro grid connection provides the lowest average cost per kWh to the community. However, it must be recognized that this option was chosen to provide a second type of Ontario Hydro system to compare with the options using the local peat resource. Since the grid connection is not consistent with normal customer demand requirements, it is unlikely that this option could become a reality for the

Cat Lake Community.

The steam engine option represents the second lowest electrical delivery costs for the milestone years of 1990 and 2000. It is significant to note that this rate grows by 53% between the years 1990 and 2000 for the steam engine while the increase is 93% for the diesel generator and 71% for the gasifier. Thus, if the project life was extended from 15 to 20 years the steam engine option would become progressively more attractive.

In considering the total impact of community electrification it is quite relevant to evaluate the associated economic benefits. The options have been treated identically in terms of electrical services provided, but they differ substantially in terms of training and annual income into the community. The training is basically proportional to the community income which can be ranked as follows:

Option	**Annual Income to Community**	
	1990	2000
. Steam Engine	$515,000	$1,072,000
. Gasifier	$460,000	$951,000
. Diesel Generator	Near Zero	Near Zero
. Grid Connection	Zero	Zero

Clearly the peat utilization options are substantially better than the two Ontario Hydro options with respect to income flowing into the community. Both of the peat options represent about $1/2 million in 1990 and $1 million in 2000 in terms of income earned within the Cat Lake Community. The steam engine option is marginally better than the gasifier.

In overall economic terms the Steam Engine option is best. The NPV is not as good as the Diesel Generator, but the annual flow of income into the community discounted to present value would more than offset the NPV difference. Costs in the form of local wages are far superior to costs for oil, transportation and other non community related expenditures. In terms of the cost per kWh to deliver electricity the diesel generator and steam engine options are essentially the same in 1990, but in the year 2000 the steam engine option delivers electrical power at 78% of the diesel generator cost with the difference growing.

The grid connection provides the lowest average cost per kWh to the community. Of the two peat utilization options the Steam Engine is superior.

9.8.3 100 Amp Scenario

The standard Ontario Hydro Diesel Generator system is not used to provide 100 Amp service to northern communities and so it has not been developed for comparison purposes. Since the 100 Amp service is not standard for remote communities it is reasonable to compare the options using the somewhat unique indigenous resource with the connection to the Ontario Hydro grid.

All of the options for the 100 Amp service result in a negative NPV over the life of the project. The life cycle costs in descending order are as follows:

Option	Net Present Value
. Grid	($2,637,000)
. Steam Engine	($2,868,000)
. Gasifier	($5,918,000)

The Grid Connection is marginally better than the Steam Engine (9%) and substantially better than the Gasifier.

The average cost per kWh delivered to the community consumers is as follows:

Option	Average Cost per kWh ($/kWh)	
	1990	2000
. Grid Connection	.09	.17
. Steam Engine	.28	.42
. Gasifier	.43	.77

The grid connection provides the lowest average cost per kWh to the community. Of the two peat utilization options the steam Engine is superior.

As described in Section 9.8.2 for the 20 Amp Scenario it is pertinent to consider the impact of community income resulting from each technical option. Training would be proportional to community income when comparing options. The annual income to the community for the milestone years is as follows:

Option	**Annual Income to Community**	
	1990	2000
. Steam Engine	$543,000	$1,121,000
. Gasifier	$490,000	$1,017,000
. Grid	0	0

This clearly demonstrates that the peat utilization options represent very significant flows of income into the Cat Lake Community annually. The Steam Engine option is marginally better than the Gasifier.

To put the economic impact of the community earned income into project perspective an additional computer run was made. For this run the value and cost of the locally earned incomes were deleted and this resulted in a negative NPV of $1,335,000. This represents an improvement of $1,533,000 to the project NPV over 15 years and the number would grow as the plant operation extended beyond this period. This effective Steam Engine NPV is 50% better than the larger Grid negative NPV of $2,637,000

In overall economic terms the Steam Engine option is superior for the 100 Amp Scenario. The NPV is within 9% of being as good as the Grid Connection in the basic computer run and it is considerably better (49%) if the NPV is compensated for the value of income. The annual incomes flowing into the community would be $543,000 and $1,121,000 for the milestone years of 1990 and 2000 respectively. Besides the income benefits it also represents worthwhile training for Peat Energy Conversion Centre personnel as well as for peat harvesters and handlers.

The Steam Engine option represents a very efficient method of electrical generation for remote community applications. The average annual cost per kWh of $.42 in the year 2000 is about the same as today's average cost of $.40 per kWh in northern community Diesel Generator facilities. In terms of year 2000 dollars the cost per kWh is 36% of the projected Diesel Generator costs. If the high initial capital costs of the Grid Connection are disregarded then this option's cost/kWh numbers are very attractive.

10.0 Conclusions and Recommendations
10.1 Conclusions

Based on the work carried out for the study, the following conclusions were made:

- The current population of Cat Lake Community of 415 is expected to increase to 750 by the year 2000. Based on the results of community survey most residents intended to stay in Cat Lake.

- The trend in housing construction indicates that nearly 75 new houses will be constructed by the year 2000.

- The total floor area of the community and support facilities is expected to increase from 2346 m^2 (1985) to 3751 m^2 (1990) to 4861 m^2 (2000) respectively.

- The projected energy needs for a 20 Amp house service scenario at the milestone years indicate an increase from 580,000 kWh consumed annually in 1985 to 1,150,000 kWh by the end of this century. The same projections for a 100 Amp service, which the community desires, would increase the annual consumption from 875,000 kWh in 1985 to about 1,730,000 kWh by the year 2000.

- The total annual peat requirements for the recommended 100 Amp scenario and sod peat space heating is estimated to be 5,200 tonnes in 1985, 6,800 tonnes in 1990 and about 8,500 tonnes by the year 2000.

- The evaluated peat resource base located within 10 km of the community is in the range of 1,500,000 to 2,000,000 tonnes of fuel grade peat; and only a portion of these deposits would be utilized to meet the projected community energy needs.

- The estimated capital cost for the proposed peat harvesting facility is in the order of $ 950,000 with annual operating costs of about $ 100,000. The cost of peat delivered to the P.E.C.C. varies from about $ 35/tonne at the start up to $ 20/tonne by the year 2000.

- There are several energy system alternatives to meet the community energy needs. The leading candidates are; a diesel generator system located in the community, connection to Ontario Hydro Grid and a Peat Energy Conversion Centre. It was concluded that a Peat Fired Boiler and Steam Engine Generator System, using proven technology, is entirely feasible.

- Potential environmental and social impacts resulting from the interaction between the proposed activities of the Cat Lake peat development and the social environmental components have been assessed. Some of the changes the proposed development will bring are considered beneficial, others unfavourable.

- Current energy demands in remote communities outstrip the rate of installation of new energy systems, and this gap is expected to widen as prices of fuel oil will escalate.

- The recommended Peat Fired Steam Engine option is, in overall economic terms, superior for the 100 Amp scenario. If implemented the estimated annual income flowing into the community would be \$ 543,000 and \$ 1,121,000 for the milestone years of 1990 and 2000 respectively.

- The implementation of the proposed peat energy system represents a worthwhile training component for peat harvesting and Peat Energy Conversion Centre personnel.

- The Steam Engine option represents a very efficient method of electrical generation for remote community applications. The average annual cost per kWh of \$ .42 in the year 2000 is about the same as today's average cost of \$ .40 per kWh in northern community Diesel Generator facilities. In terms of year 2000 dollars the cost per kWh is 36% of the projected Diesel Generator costs.

10.2 Recommendations

In view of the federal government's national off-oil policy objectives and the dependence of the Cat Lake Community on diesel fuel as its main source of energy, the following is recommended:

- The Cat Lake Community in cooperation with government agencies should utilize the local peat resource base and the available technology to substantially improve the quality of life on the reserve.

- The relevant provincial and federal institutions should place their expertise at the disposal of the program, particularly with regard to developing appropriate peat energy technologies for remote communities.

- Statistics should be routinely gathered and forecasts developed on the Canadian peat industry to aid the entire industry in the wise management of our peat resources.

- Environmental a social factors research should be included in Phase II of the program.

It is evident that the proposed peat energy system and associated know-how would be beneficial to other remote communities with indigenous peat fuel resources. In some cases, the long term cost savings and social benefits of successful use of such an energy system may spell the difference between proceeding and not proceeding with given electrification projects. More project starts would by themselves create much needed economic benefit to remote communities.

Appendix 'A'
Community Population Projections

There are three sources of population projections for the Cat Lake Indian Community which can be summarized as follows:

1) DIAND

1983 Population	339
Anticipated persons from the Osnaburgh, Slate Falls North Spirit and Pickle Lake Reserves.	60
1984 Total	399
Normal growth on the Reserves amounts to a doubling of the population every 20 years. Therefore, growth to year 2004 is	399
Projected 2004 Population	798

The doubling of the population every 20 years is equivalent to a compound growth rate of 3.528%. Using this rate and the 1984 starting population of 399 the projected populations for the study milestone years would be as follows:

1985	413
1990	491
2000	695

2) March 1984 Draft of a "Community Planning and Housing Infrastructure Servicing Feasibility Study" By Marshall Macklin Monaghan (MMM) Limited.

The draft report suggests the use of a 3.5% compound Growth Rate with a single time influx of 60 persons from other reserves in 1986. This would result in projected populations for the milestone years as follows:

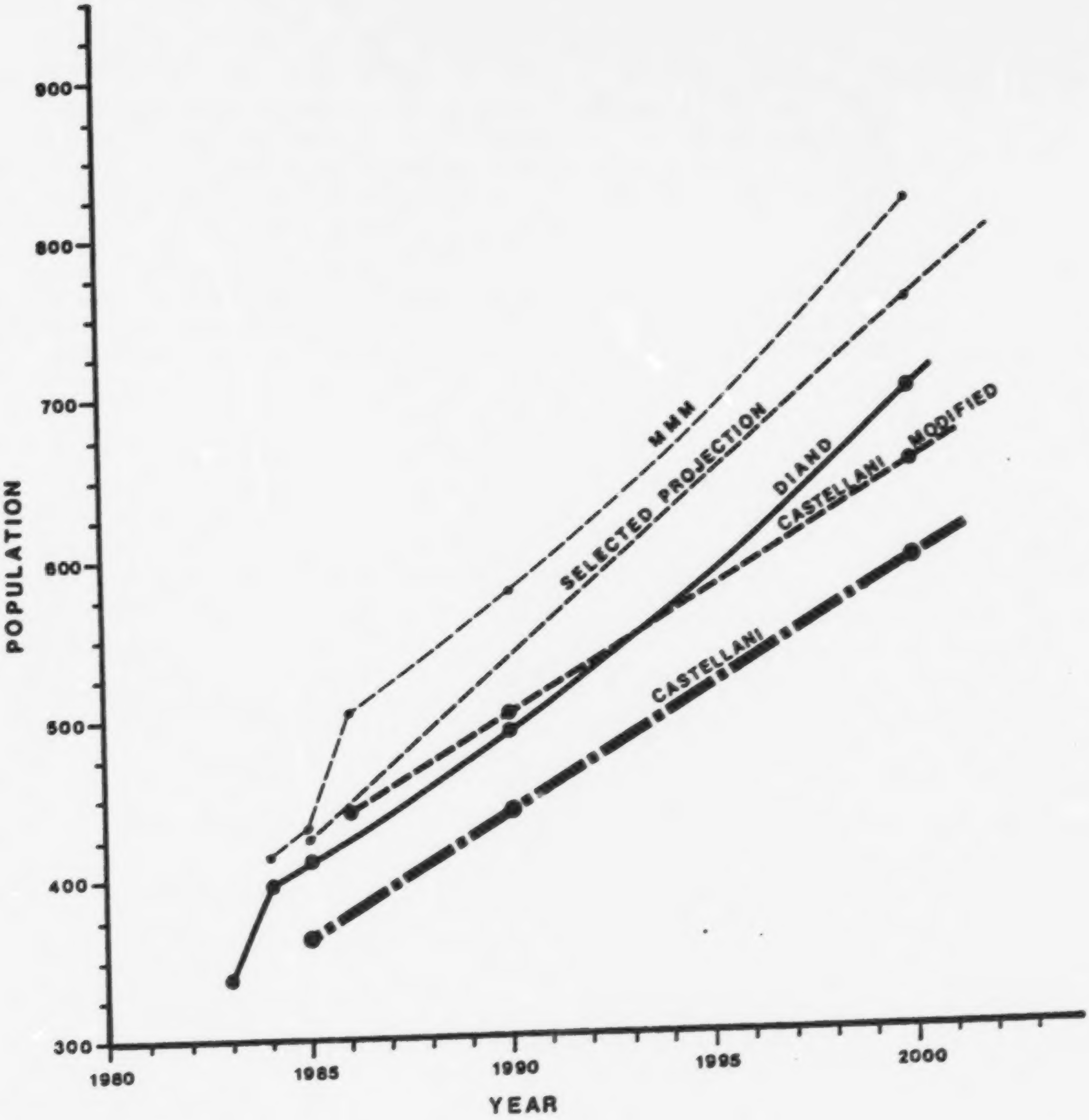
1984	Population (From Band Records)	415
1985	@ 3.5% growth	430
1990	Based on the Report figure of 589 for 1989 at a 3.5% growth rate for one year equals	579
2000	Based on the Report figure of 788 for 1999 at a 3.5% growth rate for one year equals	816

3) **Populations projections by Castellani in 1981 were as follows:**

1985	366
1990	438
2000	591

The "Castellani Modified" curve inserts the 1986 influx of 60 persons from the Osnaburgh, Slate Falls, North Spirit and Pickle Lake Reserves since this abnormal single year population rise could not have been anticipated three years ago. This curve closely conforms with the 'DIAND' curve both of which project consistently lower populations than the 'MMM' curve. The 'Selected Projection' curve falls between this range of population and appears to be reasonable for our purposes which is to validate the house projections for purposes of forecasting energy needs.

CAT LAKE INDIAN RESERVE
POPULATION PROJECTION



Appendix 'B'
Housing Projections

The projection of houses in the Cat Lake Indian Community is based on the Draft Copy of the "Community Planning and Housing Infrastructure Servicing Feasibility Study" by Marshall Macklin Monaghan Limited dated March, 1984.

a) Base Data

- 69 houses at end of 1983
- Increase in houses due to family splitting will be 1.4 houses/year for 5 years
- The 1986 influx of 60 persons from four other Reserves will represent 7 families with a house required for each.
- Replacement Program

. 1983	3
. 1984 to 1989	4/year

b) Projected Housing For Start of Milestone Year 1985

1983 - Housing stock at year end		69
"Undoubling" of families averaging 1.4 houses for 5 years results in 1984 addition of		1
Population growth demand		
. 5 years	26 houses	
. Less that required in 1986 for the influx of 60 persons (7 houses for 7 families)	7	
	19	
. Average growth excluding the one time influx of persons = 19/5 = 3.8 houses/year Therefore, 1 year at this rate		4
Projected 1985 beginning of year housing stock		74

c) Projected Housing For Start of Milestone Year 1990

. Beginning of 1985 as determined	74
. Houses required for 7 families projected to come from other Reserves in 1986	7
. Four additional years of "undoubling" of families - 4 x 1.4 = 5.6 Say	6
. Normal growth requirements of 3.8 houses/year x 5	19
Projected numbers of houses for start of year 1990	106

d) Projected Housing For Start of Milestone Year 2000

. Beginning of 1990 as determined	106
. Increase due to population growth Say 10 years @ 3.8/year	38
Projected number of houses for start of year 2000	144

The detailed breakdown of existing and new houses will be required for the annual energy projections. It is assumed that after 1984 house construction will be in accordance with new standards. References to the construction standards are as follows:

(Existing house) $68m^2$ - low wall and ceiling insulation standard (R-12) and no floor insulation
(Refer to Appendix 'C' - Case I)

(New house) $85m^2$ - better insulation standard (R-20) for floor, walls and ceiling (Refer to Appendix 'C' - Case II)

Replacement program from the MMM draft report states that starting in 1984 four houses per year will be built for five years and will continue thereafter at a rate of 3.3 houses per year.

When the foregoing house projections are compared with the selected population projections in Appendix A (i.e. populations of 425, 535 and 750 in the years 1985, 1990 and 2000 respectively) it results in the curve shown in Section 3.3.2. First glance might suggest that the year 2000 projected house total is low at 144 since the housing curve is moving very slightly away from the population after the gap was closed earlier in the projection period. The reality of the situation is that with the "Selected Population" curve being less than MMM's population projection, the number of new houses projected for the 1990 to 1995 period is high if anything. We believe that the person/house ratio of 5.74, 5.05 and 5.21 are reasonable relative to the planning objectives and the use of the housing statistics within this report.

Year	Total Houses Start of Year	Case I House			Total End of Year	Case II House			Total End of Year	Total Houses End of Year
		Existing	New	Replacement		Existing	New	Replacement		
1984	69	69	5	4	74	-	-	-	-	74
1985	74	74	-	-	70	-	6	4	10	80
1986	80	70	-	-	66	10	5	4	19	85
1987	85	66	-	-	62	19	12	4	35	97
1988	97	62	-	-	58	35	5	4	44	102
1989	102	58	-	-	54	44	4	4	52	106
1990	106	54	-	-	51	52	4	3	59	110
1991	110	51	-	-	48	59	4	3	66	114
1992	114	48	-	-	45	66	4	3	73	118
1993	118	45	-	-	42	73	4	3	80	122
1994	122	42	-	-	38	80	3	4	87	125
1995	125	38	-	-	35	87	4	3	94	129
1996	129	35	-	-	32	94	4	3	101	133
1997	133	32	-	-	29	101	4	3	108	137
1998	137	29	-	-	25	108	4	4	116	141
1999	141	25	-	-	21	116	3	4	123	144
2000	144	21	-	-		123				

Appendix 'C'
Housing Heat Loss Calculations

CASE I EXISTING HOUSES

Data:

House floor area 68 sq. meters
R12 insulation in walls
R12 insulation in ceilings
No insulation in floors
Floor is 1/4 to 1/2 meter above grade (open crawl space)
Two Doors 2'- 8" x 6'- 8" with 1 1/2 inch thick solid wood
No storm doors
Seven windows 2' x 3' double glazed, 3/16 air space (double hung, average fit)
$-32^{o}F$ outdoor design temperature
$+64^{o}F$ indoor design temperature
12,441 degree days - Per Remote Community Data Base (Pickle Lake), Volume I, 1982

HEAT LOSS CALCULATIONS

Floor

Assume house is square $68m^2 \times 10.7638 \frac{ft^2}{m^2} = 731.94\ ft^2$

Therefore $(731.94ft^2)^{\frac{1}{2}} = 27.05\ ft =$ length & width

Assume	3/4 plywood construction	R = 0.93*
	Linoleum tile covering	R = 0.05*
	Inside- still air	R = 0.92*
	Underside - still air	R = 0.92*

* R values taken from ASHRAE Load Calculation Manual. Infiltration factors for windows & doors from Lennox Load Calculation Factors

Total R = 0.05 + 0.93 + 0.92 + 0.92 = 2.82

$$U = 1/R = 1/2.82 = .3546 \frac{Btu}{hr.ft^2.^oF}$$

Assume opening banked with snow. Therefore no wind factor.

Q= U x A x T where Q= heat loss $\frac{Btu}{hr}$

U= Heat Transmission Coefficient $\frac{Btu}{hr.ft^2.^oF}$

A= surface area ft^2

T= difference between indoor & outdoor design temperatures ^oF

$$Q = .3546 \times 731.94 \times (64 - (-32)) = 24{,}916 \ \frac{\text{Btu}}{\text{hr}}$$

Ceiling

Total Ceiling Area = 731.94 ft^2

Assume

Vapor barrier R = negligible

1/2" plywood R = 0.62

Ceiling Tile R = 1.35

R12 insulation R = 12

Inside - still air R = 0.61

Above - still air R = 0.61

Total R = 0.62 + 1.35 + 12.0 + 0.61 + 0.61 = 15.19

$$U = 1/R = 1/15.19 = 0.0658 \ \frac{\text{Btu}}{\text{hr.ft}^2.^\circ\text{F}}$$

$$Q = 0.0658 \times 731.94 \times 96 = 4{,}624 \ \frac{\text{Btu}}{\text{hr}}$$

Walls

Assume 8 foot walls

Total wall area = 27.05 x 8 x 4 = 865.6 ft^2

Total door area = 18 x 2 = 36 ft^2

Total window area = 6 x 7 = 42 ft^2

Wall area net = 865.60 - 36 - 42 = 787.6 ft^2

Assume 3/8" plywood construction R = 0.47

R12 insulation R = 12

Inside Panels R = 0.23

Outside 15 mph wind R = 0.17

Inside still air R = 0.68

Total R = 0.47 + 12 + 0.23 + 0.17 + 0.68 = 13.55

$$U = 1/R = 1/13.55 = 0.0738 \ \frac{\text{Btu}}{\text{hr.ft}^2.^\circ\text{F}}$$

$$Q = 0.0738 \times 787.6 \times 96 = 5{,}580 \ \frac{\text{Btu}}{\text{hr}}$$

Doors

Conduction Loss

$Q = 0.49 \times 36 \times 96 = 1,693$

Infiltration Loss

For infiltration loss average fit doors, not weather stripped I.F. = 2 Btu per running foot of crack per ^{O}F

$Q = I.F. \times C \times T$

Where I.F. = infiltration factor Btu per hr per running foot of crack per ^{O}F

C = Crack length feet

$Q = 2 \times (19 \times 2) \times 96 = 7,296 \ \frac{Btu}{hr}$

Windows

Conduction Loss

$Q = 0.62 \times 42 \times 96 = 2,500 \ \frac{Btu}{hr}$

Infiltration Loss
Assume average fit I.F. = 0.7 Btu per hr per running foot of crack per ^{O}F

$Q = .7 \times (10 \times 7) \times 96 = 4,704 \ \frac{Btu}{hr}$

Total Heat Loss

Total Heat Loss = 24,916 + 4,624 + 5,580 + 1,693 + 7,296 +2,500 + 4,704

= 51,313 Btu/hr

Annual Energy Consumption Per House

The ASHRAE Modified Degree Day Procedure will be used. E will be calculated assuming electric resistance heating

$$E = \frac{HL \times D \times 24}{Dt \times K \times V} \times (CD)$$

where E = energy consumption for the estimate period

HL = design heat loss, including infiltration, Btu per hour

D = number of 65F degree days for the estimate period

Dt = design temperature difference, Fahrenheit

K = A correction factor which includes the effects of rated full load efficiency, part load performance, oversizing, and energy conservation devices. For electric resistance heating K=1

V = heating value of fuel, 3,413 Btu/kWh

CD = interim correction factor for heating effect vs degree days, 0.70

$$E = \frac{51{,}313 \times 12{,}441}{96 \times 1 \times 3{,}413} \times 24 \times (0.70) = 32{,}733 \text{ kWh } (117{,}838 \text{ MJ})$$

CASE II FUTURE HOUSE

Data:
Same data as Case I with the following modifications
Houses are 85 sq. meters
R20 ceilings, floors and walls
Upgraded interior panels R = 0.34

HEAT LOSS CALCULATIONS
Floor

$$R \text{ value} = 0.93 + 0.05 + 20 + .92 + .92 = 22.82$$

$$U = 1/R = 1/22.82 = 0.0438 \frac{\text{Btu}}{\text{hr.ft}^2.{}^\circ\text{F}}$$

$$Q = 0.0438 \times 914.92 \times 96 = 3{,}847 \frac{\text{Btu}}{\text{hr}}$$

Ceiling

$R \text{ value} = 0.62 + 1.35 + 20 + .61 + .61 = 23.19$

$U = 1/R = 1/23.19 = 0.0431 \dfrac{\text{Btu}}{\text{hr.ft}^2.^\circ\text{F}}$

$Q = 0.0431 \times 914.92 \times 96 = 3{,}786 \dfrac{\text{Btu}}{\text{hr}}$

Walls

$R \text{ value} = 0.47 + 20 + 0.34 + 0.17 + 0.68 = 21.66$

$U = 1/R = 1/21.66 = 0.0462 \dfrac{\text{Btu}}{\text{hr.ft}^2.^\circ\text{F}}$

$Q = 0.0462 \times 861.68 \times 96 = 3{,}822 \dfrac{\text{Btu}}{\text{hr}}$

Assume door & window losses same as Case I

Total Heat Losses

$\text{Total heat loss} = 3{,}847 + 3{,}786 + 3{,}822 + 1{,}693 + 7{,}296 + 2{,}500 + 4{,}704$

$= 27{,}648 \dfrac{\text{Btu}}{\text{hr}}$

Annual Energy Consumption Future Houses

Using modified Degree Day Procedure and same constants as Case I

$E = \dfrac{27{,}648 \times 12{,}441 \times 24 \times 0.70}{96 \times 1 \times 3{,}413} \times 1 = 17{,}637 \text{ kWh} = 63{,}493 \text{ MJ}$

Contingency to allow for construction and maintenance imperfections	6,457
Total Annual Heat Loss	69,950 MJ

There was preliminary discussion about establishing a single house model which would be used for all existing and future homes. However, based on the large difference in heat losses between the high heat loss existing house (caused by no insulation in the floor and R-12 elsewhere) and the future low loss homes (R-20 including the floors),it is deemed better to determine the house mix and calculate accordingly. To compensate for some house construction and maintenance imperfections in the efficient new houses a 10 per cent heat loss contingency has been added. On this basis the housing annual heat losses will be forecasted as follows:

Existing 68 m^2 houses - 117,838 MJ

New 85 m^2 houses - 69,950 MJ

Verification

Section 4.3.1 converts the above heat losses to the equivalent number of cords per year of typical Cat Lake wood. For the existing home this works out to be 10.6 cords of wood per house per year when using a high efficiency air tight stove at 60% efficiency (normal range is 60 - 70%) and 15.9 cords per year when using a Franklin type of stove at 40% efficiency (normal range is 30 - 40%). This can be compared with the average annual consumption of 10 cords of wood per native home as stated in 1981/2 Remote Community Data Base - Volume 2.

Appendix 'D'
Community Building Heat Loss Calculations

EXISTING SCHOOL

Data:

School Floor area 696 m^2 (7491.6 sq ft)
R14 insulation in walls (4")
R20 insulation in ceiling (6")
No insulation in floor
Crawl space insulated and heated (used for storage)
Two doors 2' 8" x 6' 8" metal doors with mineral fibre core
No storm doors
10% windows and door area
-32° F outside design temperature
$+68^\circ$ F inside design temperature
12,441 Degree Days

HEAT LOSS CALCULATIONS

Floor

Assume square building with length = width = 86.55 ft

Based on a crawl space temperature of 40° F

and $U = .3546 \dfrac{\text{Btu}}{\text{hr.}^\circ\text{F.ft}^2}$ per Appendix C Case I

$Q = .3546 \times 7491.6 \text{ ft}^2 \times (40-(-32)) = 191{,}270 \dfrac{\text{Btu}}{\text{hr}}$

Ceiling

Ceiling area = 7491.6 sq ft

Assume same construction as Appendix 'C' Case I with R20 insulation in ceiling

$R = 0.62 + 1.35 + 20 + .61 + .61 = 23.19$

$U = 1/R = 1/23.19 = 0.0431$

$Q = 7491.6 \times 100 \times 0.0431 = 32{,}289 \dfrac{\text{Btu}}{\text{hr}}$

Walls

Assume 10 foot walls

Total Wall Area = 10 x 86.55 x 4 = 3462 ft^2

Total Glass & Door Area 3462 x 10% = 346.2 ft^2

Wall Area Net 3462 - 346.2 = 3115.8 ft^2

Assume same construction as house in Appendix 'C' Case I with R14 insulation. Therefore

R = 15.66

$$U = 1/R = 1/15.66 = 0.0639 \; \frac{\text{Btu}}{\text{hr.ft}^2.^\circ\text{F}}$$

$$Q = 0.0639 \times 100 \times 3{,}115.8 = 19{,}910 \; \frac{\text{Btu}}{\text{hr}}$$

Windows

Assume double glazed 3/16" air space

$$U = 0.62 \; \frac{\text{Btu}}{\text{hr.ft}^2.^\circ\text{F}}$$

Assume windows average fit; Infiltration Factor, I.F. = 0.7

Window area = 346.2 ft^2 – door area

= 346.2 ft^2 – 36 ft^2 = 310.2 ft^2

$$Q(\text{Conduction}) = 0.62 \times 100 \times 310.2 = 19{,}232 \; \frac{\text{Btu}}{\text{hr}}$$

$$Q(\text{Infiltration}) = 0.7 \times 100 \times (21 \times 12) = 17{,}640 \; \frac{\text{Btu}}{\text{hr}}$$

Doors

For metal doors $U = \frac{0.59\ \text{Btu}}{\text{hr.ft}^2.^{o}\text{F}}$

Assume average fit doors not weather stripped.

Infiltration Factor = 2 Btuh per running foot of crack per ^{o}F.

Q(Conduction) $= 0.59 \times 100 \times 36 = 2{,}124\ \frac{\text{Btu}}{\text{hr}}$

Q(Infiltration) $= 2 \times 100 \times 38 = 7{,}600\ \frac{\text{Btu}}{\text{hr}}$

Total Heat Losses $= 191{,}270 + 32{,}289 + 19{,}910 + 19{,}232 + 17{,}640 + 2{,}124 + 7{,}600$

$= 290{,}065\ \frac{\text{Btu}}{\text{hr}}$

Annual Energy Consumption School

Using modified degree day procedure and same constants as in Appendix 'C'

$$E = \frac{290{,}065 \times 12{,}441 \times 24 \times 0.7}{100 \times 1 \times 3{,}413} = 177{,}633\ \text{kWh}$$

1 kWh = 3.6 MJ

Equivalent MJ = 177,633 x 3.6

= 639,479 MJ

Verification

1981/82 Fuel Oil to community 116,826 litres

$$\text{Commercial and Institutional Space Heating} = 116{,}826 \times \frac{56}{100}$$

$$= 65{,}423 \text{ litres/year}$$

Community Buildings currently heated by oil are as follows:

Building	**Size (m^2)**
School	696
Teacherage	251
Health Centre (NHW)	46
Warehouse/Agency Cabin	116
Total	1,109 m^2

Ratioing the school area to the total to assign annual oil consumption results in the following:

$$\text{Annual school oil consumption} = 65{,}423 \times \frac{696}{1{,}109}$$

$$= 41{,}059 \text{ litres/year}$$

The school oil consumption would in reality be less since the other buildings are built to lower energy conserving standards. On a heat loss weighted basis using the existing house standard from Appendix 'C' for all buildings, excluding the school, the annual oil consumption assigned to the school would be 50% of the total oil which equals 32,712 litres. This would be a more realistic volume of oil than the previously calculated 41,059 litres.

Bases on the calculated annual school heat loss of 639,479 MJ from Appendix 'D' and efficiency of 60% the required annual oil would be as follows:

$$\text{Annual oil in litres} = \frac{639{,}479}{38.68 \times .6}$$

$$= 27{,}554 \text{ litres}$$

Relative to the historical annual oil consumption the difference from the annual heat loss calculations is as follows:

$$\% \text{ Difference} = \frac{(32,712 - 27,554)}{32,712} 100$$

$$= 16\%$$

The above "% Difference" could be explained by combinations of seasonal difference, the accounting split between oil for heating and electrical generation and the heat loss assumptions. It is close enough to confirm that the calculations are reasonable.

Unit Heat Loss Factors

In discussions with DIAND and MNA it was agreed that community building standards would be quantified as follows:-

- The school and all future community buildings would be based on the current school design standards. In accordance with the foregoing calculations in this Appendix the annual average design heat loss of

$$\frac{639,479}{696} = 919 \text{ MJ/m}^2\text{/year}$$

- Existing community buildings would be based on a building standard the same as the existing houses. This is the same as Case I in Appendix 'C' and provides a unit heat loss as follows:

$$\text{Heat loss/m}^2\text{/year} = \frac{117,838}{68} \text{ MJ}$$

$$= 1733 \text{ MJ/m}^2\text{/year}$$

'Appendix E'
Extra Peat For Electric Versus Direct Peat Space Heating

Please refer to text Section 4.4

Assume 1000 tonnes of peat are harvested per year and this is sufficient to supply heat when burned in a stove with 50% efficiency.

Assume a 6% loss of peat for home delivery.

Assume 14% efficiency when burning peat to produce electricity.

Calculate % increase in harvested peat needed if an assumed 25% of the present heating load is converted from peat thermal energy to electric resistance heat energy with an efficiency of 1.0

Calculations

Peat Actually burned = Harvested peat - Delivery Loss
= 1000 - (1000 x .06)
= 940 tonnes

Thermal heat = 940 tonnes x efficiency
= 940 x .50
= 470 tonnes

Amount to be converted to electric heat = 470 tonnes x .25
= 117.5 tonnes

Remainder of peat thermal heat = 470 - 117.5
= 352.5 tonnes

To produce by electric heat the equivalent of 117.5 tonnes of peat thermal heat one would have to harvest

$$\frac{117.5}{.14} \text{ tonnes} = 839.3 \text{ tonnes}$$

Converting 117.5 tonnes of peat thermal heat to tonnes of peat actually harvested equals:-.

117.5 x reciprocal of 50% burning efficiency x 1.06 which accounts for previous delivery losses.

$117.5 \times 2 \times 1.06 = 249.1$ tonnes

Actual peat that was harvested to produce peat thermal heat is

$1000 - 249.1 = 750.9$ tonnes

Total Peat harvested to produce 75% of heat thermally and 25% of heat electrically is

$750.9 + 839.3 = 1590.2$ tonnes

% increase in harvested peat needed to produce the 75/25 heat ratio is

$$\frac{1590.2-1000}{1000} \times 100 = 59\%$$

APPENDIX F

SCHEDULE A

Rates for Isolated Generation Communities

	Air Access Communities	Road/Rail Access Communities
RESTRICTED RESIDENTIAL SERVICE		
All Energy (¢ per kWh)	44.2	32.7
Minimum monthly charge	$5.50	$5.50
Rural Rate Assistance		
First 250 kWh per month (¢ per kWh)	(35.34)	(23.84)
Balance (¢ per kWh)	(32.4)	(20.9)
Effective Rates		
First 250 kWh per month (¢ per kWh)	8.86	8.86
Balance (¢ per kWh)	11.8	11.8
STANDARD SERVICE "A"		
All Energy (¢ per kWh)	44.2	32.7
Minimum monthly charge	$5.50	$5.50
Rural Rate Assistance (Residential Only)		
First 250 kWh per month (¢ per kWh)	(2.94)	(2.94)
Effective Rates (Residential Only)		
First 250 kWh per month (¢ per kWh)	41.26	29.76
Balance (¢ per kWh)	44.2	32.7
STANDARD SERVICE "B"		
All energy (¢ per kWh)	29.5	21.8
Minimum monthly charge	$5.50	$5.50
Rural Rate Assistance (Residential Only)		
First 250 kWh per month (¢ per kWh)	(2.94)	(2.94)

Sheet Number 4

	Air Access Communities	Road/Rail Access Communities
Effective Rates (Residential Only)		
First 250 kWh per month (¢ per kWh)	26.56	18.86
Balance (¢ per kWh)	29.5	21.8
RESIDENTIAL ,INTERMITTENT OCCUPANCY		
All Energy (¢ per kWh)	29.5	21.8
Minimum monthly charge	$5.50	$5.50
Late Payment Charge (applicable to all of above rates)	5 per cent	5 per cent
STREET LIGHTING		
All Energy (¢ per kWh)	44.2	32.7

APPENDIX G - ECONOMIC ANALYSIS COMPUTER PRINTOUTS

```
                                        PROJECT STATISTICS
                                     CAT LAKE ELECTRIFICATION

                                           OUTPUT DATA
                                           -----------

 STEAM ANNUAL OUTPUT                      0

                                           INPUT DATA
                                           ----------

 MILL WASTE ANNUAL CONSUMPTION            0


                                     BASE YEAR VARIABLE COSTS
                                     ------------------------

 CHEMICAL AND OTHER COSTS                 0
 VARIABLE LABOUR COSTS                    0
 TRANSPORT COSTS                          0




 OTHER VARIABLE COSTS                     0

                                      BASE YEAR FIXED COSTS
                                      ---------------------

 FIXED LABOUR                             0
 FIXED SUPERVISORY LABOUR                 0
 FIXED ADMINISTRATIVE LABOUR              0
 OTHER ADMINISTRATIVE COSTS               0
 MAINTENANCE AND MATERIALS COSTS      9.520
 PROPERTY TAXES                           0
 INSURANCE COST                           0
 OTHER FIXED COSTS                        0
```

Grid Connection
20 Amp.

```
                                              CAPITAL COST ESTIMATES

                                                BASE YEAR ESTIMATE
                                               -------------------
                              1984     1985     1986     1987
                            -------  -------  -------  -------
LAND COST
EQUIPMENT CLASS A                               2,595    2,595
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT



                                           INSERVICE COST BREAKDOWN
                                           ------------------------
LAND COST
EQUIPMENT CLASS A                               3,004    3,233
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT
TOTAL ANNUAL CAP COST                           3,004    3,233
CUMULATIVE CAPITAL COST                         3,004    6,237

                                               INSERVICE COSTS
                                               ---------------

CONSTRUCTION OUTLAY                             3,004    3,233
INTEREST ON CONSTRUCTION
WORKING CAPITAL
TOTAL INSERVICE COST                            3,004    3,233
```

INFLATION RATES
(% INCREASE OVER PREVIOUS YEAR)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
REVENUE ESCALATORS															
STEAM INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
ELECTRICITY INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER PRODUCT INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
FEEDSTOCK INFLATORS															
MILL WASTE INFLATOR	.0780	.0780	.0780	.0780	.0670	.0670	.0670	.0670	.0670	.0650	.0650	.0650	.0650	.0650	.0650
OTHER FEEDSTOCK INFLATOR	.0780	.0780	.0780	.0780	.0670	.0670	.0670	.0670	.0670	.0650	.0650	.0650	.0650	.0650	.0650
GENERAL PRICE INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
FOSSIL FUEL INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
LABOUR INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
TRANSPORT INFLATOR	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800

PROJECT STATISTICS
CAT LAKE ELECTRIFICATION

	2001	2002
REVENUE ESCALATORS		
STEAM INFLATOR	.0770	.0770
ELECTRICITY INFLATOR	.0770	.0770
OTHER PRODUCT INFLATOR	.0770	.0770
FEEDSTOCK INFLATORS		
MILL WASTE INFLATOR	.0650	.0650
OTHER FEEDSTOCK INFLATOR	.0650	.0650
GENERAL PRICE INFLATOR	.0710	.0710
FOSSIL FUEL INFLATOR	.0770	.0770
LABOUR INFLATOR	.0710	.0710
TRANSPORT INFLATOR	.0800	.0800

INPUT: GENREPORT INCOME

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMEN
CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCT PRICES										
STEAM PRICE	.44	.48	.52	.57	.62	.67	.73	.80	.87	.95
ELECTRICITY PRICE	.10	.11	.12	.13	.14	.16	.17	.19	.20	.22
OTHER PRODUCT PRICE										
REVENUES										
STEAM REVENUE					115	137	161	181	204	228
ELECTRICITY REVENUE					84	96	109	123	139	157
OTHER PRODUCT REVENUE										
	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL REVENUES					200	233	270	305	343	386
VARIABLE COSTS										
MILL WASTE COST					52	59	66	73	80	88
OTHER FEEDSTOCK COST					24	28	31	35	39	42
	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL FEEDSTOCK COSTS					76	87	97	107	118	130
OTHER VARIABLE EXPENSES										
VARIABLE LABOUR COST										
CHEMICAL AND OTHER COST										
TRANSPORT COST										
	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
OTHER VARIABLE EXPENSES										
	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL VARIABLE COSTS					76	87	97	107	118	130

FIXED OPERATING LABOUR COSTS										
FIXED SUPERVISORY LABOUR COSTS										
MAINTENANCE MATERIALS COST					13	14	15	16	17	18
FIXED ADMINISTRATIVE LABOUR CO										
ADMINISTRATIVE COST										
PROPERTY TAX										
INSURANCE COSTS										
OTHER FIXED COST										
	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL FIXED COSTS					13	14	15	16	17	18
	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL OPERATING COSTS					89	101	112	123	135	148
	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
NET OPERATING MARGIN					111	133	159	182	208	237

CAPITALIZATION

PRIVATE EQUITY	
TOTAL CAPITAL	6,237

ECONOMIC ANALYSIS

NPV NET OPERATING MARGIN	(3,615)
PROJECT IRR TO TOTAL CAPITAL	(1.00)
SIMPLE PAYBACK YEARS	
DISCOUNTED PAYBACK YEARS	

```
                                              LEVELIZED COSTS UF PROJECT
                                              **************************

STEAM LEVELIZED COST              999999

LEVELIZED BYPRODUCT CREDIT        999999
LEVELIZED FEEDSTOCK COST          999999
LEVELIZED O AND M COST            999999
LEVELIZED CAPITAL COST            999999

                                                 CAPITAL RECOVERY
                                                 ****************

ANNUAL CAPITAL RECOVERY FACTOR       .20
AVERAGE PRICE MULTIPLIER            1.52
STEAM REQUIRED PRICE
```

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1994	1995	1996	1997	1998	1999	2000	2001	2002
PRODUCT PRICES									
STEAM PRICE	1.04	1.13	1.22	1.31	1.41	1.52	1.64	1.76	1.90
ELECTRICITY PRICE	.24	.26	.28	.31	.33	.36	.38	.41	.44
OTHER PRODUCT PRICE									
REVENUES									
STEAM REVENUE	256	287	317	350	387	426	470	506	545
ELECTRICITY REVENUE	177	198	220	245	271	301	331	356	384
OTHER PRODUCT REVENUE									
TOTAL REVENUES	433	485	537	595	658	727	801	863	929
VARIABLE COSTS									
MILL WASTE COST	97	105	114	127	140	153	167	177	189
OTHER FEEDSTOCK COST	47	51	56	61	68	74	80	85	91
TOTAL FEEDSTOCK COSTS	144	157	172	189	208	227	247	263	280
OTHER VARIABLE EXPENSES									
VARIABLE LABOUR COST									
CHEMICAL AND OTHER COST									
TRANSPORT COST									
OTHER VARIABLE EXPENSES									
TOTAL VARIABLE COSTS	144	157	172	189	208	227	247	263	280

FIXED OPERATING LABOUR COSTS									
FIXED SUPERVISORY LABOUR COSTS									
MAINTENANCE MATERIALS COST	19	21	22	24	25	27	29	31	33
FIXED ADMINISTRATIVE LABOUR CO									
ADMINISTRATIVE COST									
PROPERTY TAX									
INSURANCE COSTS									
OTHER FIXED COST									
	------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL FIXED COSTS	19	21	22	24	25	27	29	31	33
	------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL OPERATING COSTS	163	177	194	212	233	254	276	294	313
	------	-------	-------	-------	-------	-------	-------	-------	-------
NET OPERATING MARGIN	270	308	343	382	424	473	525	569	616

Grid Connection
100 Amp

```
                                           PROJECT STATISTICS
                                        CAT LAKE ELECTRIFICATION

                                              OUTPUT DATA
                                              -----------

STEAM ANNUAL OUTPUT                     0



                                              INPUT DATA
                                              ----------

MILL WASTE ANNUAL CONSUMPTION           0

                                        BASE YEAR VARIABLE COSTS
                                        ------------------------

CHEMICAL AND OTHER COSTS                0
VARIABLE LABOUR COSTS                   0
TRANSPORT COSTS                         0
OTHER VARIABLE COSTS                    0

                                          BASE YEAR FIXED COSTS
                                          ---------------------

FIXED LABOUR                            0
FIXED SUPERVISORY LABOUR                0
FIXED ADMINISTRATIVE LABOUR             0
OTHER ADMINISTRATIVE COSTS              0
MAINTENANCE AND MATERIALS COSTS     9,520
PROPERTY TAXES                          0
INSURANCE COST                          0
OTHER FIXED COSTS                       0
```

```
                                         CAPITAL COST ESTIMATES

                                          BASE YEAR ESTIMATE

                                          ------------------
                          1984     1985     1986      1987
                         ------  -------  -------   -------
LAND COST
EQUIPMENT CLASS A                           2,595     2,595
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT

                                       INSERVICE COST BREAKDOWN
                                       ------------------------

LAND COST
EQUIPMENT CLASS A                           3,004     3,233
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT
TOTAL ANNUAL CAP COST                       3,004     3,233
CUMULATIVE CAPITAL COST                     3,004     6,237

                                             INSERVICE COSTS
                                             ---------------

CONSTRUCTION OUTLAY                         3,004     3,233
INTEREST ON CONSTRUCTION
WORKING CAPITAL
TOTAL INSERVICE COST                        3,004     3,233
```

INFLATION RATES
(% INCREASE OVER PREVIOUS YEAR)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
REVENUE ESCALATORS															
STEAM INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
ELECTRICITY INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER PRODUCT INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
FEEDSTOCK INFLATORS															
MILL WASTE INFLATOR	.0780	.0780	.0780	.0780	.0670	.0670	.0670	.0670	.0670	.0650	.0650	.0650	.0650	.0650	.0650
OTHER FEEDSTOCK INFLATOR	.0780	.0780	.0780	.0780	.0670	.0670	.0670	.0670	.0670	.0650	.0650	.0650	.0650	.0650	.0650
GENERAL PRICE INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
FOSSIL FUEL INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
LABOUR INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
TRANSPORT INFLATOR	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800

```
                                                  PROJECT STATISTICS
                                               CAT LAKE ELECTRIFICATION

                                2001   2002
                                ----   ----
 REVENUE ESCALATORS
 ------------------
 STEAM INFLATOR                .0770  .0770
 ELECTRICITY INFLATOR          .0770  .0770
 OTHER PRODUCT INFLATON        .0770  .0770

 FEEDSTOCK INFLATORS
 -------------------
 MILL WASTE INFLATOR           .0650  .0650
 OTHER FEEDSTOCK INFLATOR      .0650  .0650

 GENERAL PRICE INFLATON        .0710  .0710

 FOSSIL FUEL INFLATON          .0770  .0770
 LABOUR INFLATOR               .0710  .0710
 TRANSPORT INFLATOR            .0800  .0800
```

INPUT:
INPUT: GENREPORT INCOME

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCT PRICES										
STEAM PRICE	.44	.48	.52	.57	.62	.67	.73	.80	.87	.95
ELECTRICITY PRICE	.10	.11	.12	.13	.14	.16	.17	.19	.20	.22
OTHER PRODUCT PRICE										
REVENUES										
STEAM REVENUE					184	218	257	289	324	363
ELECTRICITY REVENUE					223	255	289	327	369	417
OTHER PRODUCT REVENUE										
TOTAL REVENUES					407	473	546	616	693	780
VARIABLE COSTS										
MILL WASTE COST					52	59	66	73	80	88
OTHER FEEDSTOCK COST					89	101	113	125	138	153
TOTAL FEEDSTOCK COSTS					141	160	179	198	218	241
OTHER VARIABLE EXPENSES										
VARIABLE LABOUR COST										
CHEMICAL AND OTHER COST										
TRANSPORT COST										
OTHER VARIABLE EXPENSES										
TOTAL VARIABLE COSTS					141	160	179	198	218	241

```
FIXED OPERATING LABOUR COSTS
FIXED SUPERVISORY LABOUR COSTS                                        13       14       15       16       17       18
MAINTENANCE MATERIALS COST
FIXED ADMINISTRATIVE LABOUR CO
ADMINISTRATIVE COST
PROPERTY TAX
INSURANCE COSTS
OTHER FIXED COST                                                   -------  -------  -------  -------  -------  -------
                              ------   -------  -------  -------       13       14       15       16       17       18
 TOTAL FIXED COSTS                                                 -------  -------  -------  -------  -------  -------
                              ------   -------  -------  -------      153      174      193      213      235      259
 TOTAL OPERATING COSTS                                             -------  -------  -------  -------  -------  -------
                              ------   -------  -------  -------      253      296      352      402      456      521
 NET OPERATING MARGIN

 CAPITALIZATION
 --------------
 PRIVATE EQUITY
 TOTAL CAPITAL                 6,237


 ECONOMIC ANALYSIS
 -----------------
 NPV NET OPERATING MARGIN     (2,637)
 PROJECT IRR TO TOTAL CAPITAL     .05
 SIMPLE PAYBACK YEARS           11.46
 DISCOUNTED PAYBACK YEARS
```

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1994	1995	1996	1997	1998	1999	2000	2001	2002
PRODUCT PRICES									
STEAM PRICE									
ELECTRICITY PRICE	1.04	1.13	1.22	1.31	1.41	1.52	1.64	1.76	1.90
OTHER PRODUCT PRICE	.24	.26	.28	.31	.33	.36	.38	.41	.44
REVENUES									
STEAM REVENUE									
ELECTRICITY REVENUE	407	456	504	557	615	678	749	806	868
OTHER PRODUCT REVENUE	470	525	584	648	719	797	877	944	1,017
TOTAL REVENUES	877	981	1,088	1,205	1,334	1,475	1,625	1,751	1,885
VARIABLE COSTS									
MILL WASTE COST	97	105	116	127	140	153	167	177	189
OTHER FEEDSTOCK COST	166	184	202	221	243	266	289	306	328
TOTAL FEEDSTOCK COSTS	265	289	316	349	382	419	456	485	517
OTHER VARIABLE EXPENSES									
VARIABLE LABOUR COST									
CHEMICAL AND OTHER COST									
TRANSPORT COST									
OTHER VARIABLE EXPENSES									
TOTAL VARIABLE COSTS	265	289	316	349	382	419	456	485	517

```
                                      LEVELIZED COSTS OF PROJECT
                                      --------------------------

STEAM LEVELIZED COST             999999

LEVELIZED BYPRODUCT CREDIT       999999
LEVELIZED FEEDSTOCK COST         999999
LEVELIZED O AND M COST           999999
LEVELIZED CAPITAL COST           999999
                                         CAPITAL RECOVERY
                                         ----------------

ANNUAL CAPITAL RECOVERY FACTOR      .26
AVERAGE PRICE MULTIPLIER            .88
STEAM REQUIRED PRICE
```

```
FIXED OPERATING LABOUR COSTS
FIXED SUPERVISORY LABOUR COSTS
MAINTENANCE MATERIALS COST          19       21       22       24       25       27       29       31       33
FIXED ADMINISTRATIVE LABOUR CO
ADMINISTRATIVE COST
PROPERTY TAX
INSURANCE COSTS
OTHER FIXED COST
                                ------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL FIXED COSTS                   19       21       22       24       25       27       29       31       33
                                ------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL OPERATING COSTS              265      310      340      372      406      446      485      517      550
                                ------  -------  -------  -------  -------  -------  -------  -------  -------
NET OPERATING MARGIN               593      671      748      833      926    1,029    1,141    1,234    1,335
```

Cat Lake
Diesel Generator
20 Amp

```
INPUT: NORECORD
READY FOR MODELING LANGUAGE COMMAND
INPUT: SOLVE
ENTER SOLVE OPTIONS
INPUT: GENREPORT TOTAL

                                                  PROJECT STATISTICS
                                               CAT LAKE ELECTRIFICATION

                                                     OUTPUT DATA
                                                     -----------

     STEAM ANNUAL OUTPUT                       0
                                                     INPUT DATA
                                                     ----------

     MILL WASTE ANNUAL CONSUMPTION             0

                                                BASE YEAR VARIABLE COSTS
                                                ------------------------

     CHEMICAL AND OTHER COSTS                  0
     VARIABLE LABOUR COSTS                     0
     TRANSPORT COSTS                           0
     OTHER VARIABLE COSTS                      0

                                                  BASE YEAR FIXED COSTS
                                                  ---------------------

     FIXED LABOUR                              0
     FIXED SUPERVISORY LABOUR                  0
     FIXED ADMINISTRATIVE LABOUR               0
     OTHER ADMINISTRATIVE COSTS                0
     MAINTENANCE AND MATERIALS COSTS     110,690
     PROPERTY TAXES                            0
     INSURANCE COST                        7,582
     OTHER FIXED COSTS                         0
```

```
                                                    CAPITAL COST ESTIMATES

                                                     BASE YEAR ESTIMATE
                                                     ------------------
                                         1984    1985    1986    1987
                                        ------  ------- ------- -------
    LAND COST                                             632     632
    EQUIPMENT CLASS A
    EQUIPMENT CLASS B
    EQUIPMENT CLASS C
    EQUIPMENT CLASS D
    ENGINEERING AND PROJECT MGMT

                                                  INSERVICE COST BREAKDOWN
                                                  ------------------------

    LAND COST                                             731     787
    EQUIPMENT CLASS A
    EQUIPMENT CLASS B
    EQUIPMENT CLASS C
    EQUIPMENT CLASS D
    ENGINEERING AND PROJECT MGMT                          731     787
    TOTAL ANNUAL CAP COST                                 731   1,518
    CUMULATIVE CAPITAL COST

                                                      INSERVICE COSTS
                                                      ---------------

                                                          731     787
    CONSTRUCTION OUTLAY
    INTEREST ON CONSTRUCTION
    WORKING CAPITAL                                       731     787
    TOTAL INSERVICE COST
```

INFLATION RATES
(% INCREASE OVER PREVIOUS YEAR)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
REVENUE ESCALATIONS															
STEAM INFLATION	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
ELECTRICITY INFLATION	.0880	.0880	.0880	.0880	.0860	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER PRODUCT INFLATION	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
FEEDSTOCK INFLATIONS															
MILL WASTE INFLATION	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER FEEDSTOCK INFLATION	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
GENERAL PRICE INFLATION	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
FOSSIL FUEL INFLATION	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
LABOUR INFLATION	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
TRANSPORT INFLATION	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800

```
                                   PROJECT STATISTICS
                                 CAT LAKE ELECTRIFICATION

                              2001   2002
                              ----   ----
REVENUE ESCALATORS
------------------
STEAM INFLATION               .0770  .0770
ELECTRICITY INFLATION         .0770  .0770
OTHER PRODUCT INFLATION       .0770  .0770

FEEDSTOCK INFLATIONS
--------------------
MILL WASTE INFLATION          .0770  .0770
OTHER FEEDSTOCK INFLATION     .0770  .0770

GENERAL PRICE INFLATION       .0710  .0710

FOSSIL FUEL INFLATION         .0770  .0770
LABOUR INFLATION              .0710  .0710
TRANSPORT INFLATION           .0400  .0000
```

INPUT: GENREPORT INCOME

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCT PRICES										
STEAM PRICE	48.00	52.22	56.82	61.82	67.26	73.18	79.62	86.62	94.90	103.25
ELECTRICITY PRICE	.44	.48	.52	.57	.62	.67	.73	.80	.87	.95
OTHER PRODUCT PRICE	.10	.11	.12	.13	.14	.16	.17	.19	.20	.22
REVENUES										
STEAM REVENUE					115	137	161	181	204	228
ELECTRICITY REVENUE					84	96	109	123	139	157
OTHER PRODUCT REVENUE										
TOTAL REVENUES					200	233	270	305	343	386
VARIABLE COSTS										
MILL WASTE COST					239	287	328	371	418	471
OTHER FEEDSTOCK COST										
TOTAL FEEDSTOCK COSTS					239	287	328	371	418	471
OTHER VARIABLE EXPENSES										
VARIABLE LABOUR COST										
CHEMICAL AND OTHER COST										
TRANSPORT COST										
OTHER VARIABLE EXPENSES										
TOTAL VARIABLE COSTS					239	287	328	371	418	471

```
FIXED OPERATING LABOUR COSTS
FIXED SUPERVISORY LABOUR COSTS
MAINTENANCE MATERIALS COST                                              150      168      180      193      207      221
FIXED ADMINISTRATIVE LABOUR CO
ADMINISTRATIVE COST
PROPERTY TAX                                                              9       10       10       11       11       12
INSURANCE COSTS
OTHER FIXED COST
                           ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL FIXED COSTS                                                        160      178      190      204      218      233
                           ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL OPERATING COSTS                                                    405      465      519      574      636      705
                           ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
NET OPERATING MARGIN                                                   (205)    (232)    (268)    (278)    (293)    (319)

CAPITALIZATION


--------------
PRIVATE EQUITY
TOTAL CAPITAL               1,518

ECONOMIC ANALYSIS
-----------------
NPV NET OPERATING MARGIN   (2,182)
PROJECT IRR TO TOTAL CAPITAL (1.00)
SIMPLE PAYBACK YEARS
DISCOUNTED PAYBACK YEARS
```

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION

THOUSANDS OF DOLLARS

	1994	1995	1996	1997	1998	1999	2000	2001	2002
PRODUCT PRICES									
STEAM PRICE	112.59	122.78	132.24	142.42	153.39	165.20	177.92	191.62	206.37
ELECTRICITY PRICE	1.04	1.13	1.22	1.31	1.41	1.52	1.64	1.76	1.90
OTHER PRODUCT PRICE	.24	.26	.28	.31	.33	.36	.38	.41	.44
REVENUES									
STEAM REVENUE									
ELECTRICITY REVENUE	256	287	317	350	387	426	470	506	545
OTHER PRODUCT REVENUE	177	198	220	245	271	301	331	356	384
TOTAL REVENUES	433	485	537	595	659	727	801	863	929
VARIABLE COSTS									
MILL WASTE COST									
OTHER FEEDSTOCK COST	531	593	659	730	809	896	986	1,062	1,144
TOTAL FEEDSTOCK COSTS	531	593	659	730	809	896	986	1,062	1,144
OTHER VARIABLE EXPENSES									
VARIABLE LABOR COST									
CHEMICAL AND OTHER COST									
TRANSPORT COST									
OTHER VARIABLE EXPENSES									
TOTAL VARIABLE COSTS	531	593	659	730	809	896	986	1,062	1,144

```
                                          LEVELIZED COSTS IN PROJECT
                                          --------------------------

  STEAM LEVELIZED COST              999999

  LEVELIZED BYPRODUCT CREDIT        999999
  LEVELIZED FEEDSTOCK COST          999999
  LEVELIZED O AND M COST            999999
  LEVELIZED CAPITAL COST            999999



                                             CAPITAL RECOVERY
                                             ----------------

  ANNUAL CAPITAL RECOVERY FACTOR       .20
  AVERAGE PRICE MULTIPLIER            2.00
  STEAM REQUIRED PRICE              404.80
```

FIXED OPERATING LABOUR COSTS									
FIXED SUPERVISORY LABOUR COSTS									
MAINTENANCE MATERIALS COST	237	254	272	291	312	334	356	383	411
FIXED ADMINISTRATIVE LABOUR CO									
ADMINISTRATIVE COST									
PROPERTY TAX									
INSURANCE COSTS	12	13	14	14	15	16	17	17	18
OTHER FIXED COST									
	------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL FIXED COSTS	250	267	286	306	327	350	374	401	429
	------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL OPERATING COSTS	780	860	944	1,036	1,130	1,240	1,360	1,463	1,573
	------	-------	-------	-------	-------	-------	-------	-------	-------
NET OPERATING MARGIN	(347)	(375)	(407)	(441)	(478)	(519)	(559)	(600)	(643)

Cat Lake
Gasifier
20 Amps

```
UNDEFINED VARIABLE O
MODEL CLINT  VERSION OF  03/29/84  09:31 -- 19 COLUMNS 339 VARIABLES
ERROR(S) SHOULD BE CORRECTED
INPUT: SOLVE
ENTER SOLVE OPTIONS
INPUT: GENREPORT TOTAL

                                             PROJECT STATISTICS
                                          CAT LAKE ELECTRIFICATION

                                                OUTPUT DATA
                                                -----------

STEAM ANNUAL OUTPUT                         0
                                                INPUT DATA
                                                ----------

MILL WASTE ANNUAL CONSUMPTION               0

                                          BASE YEAR VARIABLE COSTS
                                          ------------------------

CHEMICAL AND OTHER COSTS                    0
VARIABLE LABOUR COSTS                       0
TRANSPORT COSTS                             0
OTHER VARIABLE COSTS                        0
                                            BASE YEAR FIXED COSTS
                                            ---------------------

FIXED LABOUR                                0
FIXED SUPERVISORY LABOUR                    0
FIXED ADMINISTRATIVE LABOUR                 0
OTHER ADMINISTRATIVE COSTS                  0
MAINTENANCE AND MATERIALS COSTS       272,300
PROPERTY TAXES                              0
INSURANCE COST                         19,020
OTHER FIXED COSTS                           0
```

```
                                                  CAPITAL COST ESTIMATES

                                                   BASE YEAR ESTIMATE
                                                  ------------------
                                1984     1985     1986     1987
                              ------  -------  -------  -------
LAND COST
EQUIPMENT CLASS A                                 1,830    1,830
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT

                                              INSERVICE COST BREAKDOWN
                                              ------------------------
LAND COST
EQUIPMENT CLASS A                                 2,119    2,280
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT
TOTAL ANNUAL CAP COST                             2,119    2,280
CUMULATIVE CAPITAL COST                           2,119    4,398

                                                  INSERVICE COSTS
                                                  ---------------

CONSTRUCTION OUTLAY                               2,119    2,280
INTEREST ON CONSTRUCTION
WORKING CAPITAL
TOTAL INSERVICE COST                              2,119    2,280
```

INFLATION RATES
(% INCREASE OVER PREVIOUS YEAR)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
REVENUE ESCALATORS															
STEAM INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
ELECTRICITY INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER PRODUCT INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
FEEDSTOCK INFLATORS															
MILL WASTE INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER FEEDSTOCK INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
GENERAL PRICE INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
FOSSIL FUEL INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
LABOUR INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
TRANSPORT INFLATOR	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800

```
                              PROJECT STATISTICS
                           CAT LAKE ELECTRIFICATION

                           2001   2002
                           ----   ----
REVENUE ESCALATORS
------------------
STEAM INFLATOR             .0770  .0770
ELECTRICITY INFLATOR       .0770  .0770
OTHER PRODUCT INFLATOR     .0770  .0770

FEEDSTOCK INFLATORS
-------------------
MILL WASTE INFLATOR        .0770  .0770
OTHER FEEDSTOCK INFLATOR   .0770  .0770

GENERAL PRICE INFLATOR     .0710  .0710

FOSSIL FUEL INFLATOR       .0770  .0770
LABOUR INFLATOR            .0710  .0710
TRANSPORT INFLATOR         .0800  .0800
```

INPUT: GENREPORT INCOME

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCT PRICES										
STEAM PRICE	48.00	52.22	56.82	61.82	67.26	73.18	79.62	86.62	94.66	103.26
ELECTRICITY PRICE	.44	.48	.52	.57	.62	.67	.73	.80	.87	.95
OTHER PRODUCT PRICE	.10	.11	.12	.13	.14	.16	.17	.19	.20	.22
REVENUES										
STEAM REVENUE					52	113	184	201	219	239
ELECTRICITY REVENUE					115	137	161	181	204	228
OTHER PRODUCT REVENUE					84	96	109	123	139	157
TOTAL REVENUES					251	346	454	505	562	625
VARIABLE COSTS										
MILL WASTE COST					102	151	199	219	241	265
OTHER FEEDSTOCK COST					102	122	142	160	180	201
TOTAL FEEDSTOCK COSTS					204	274	341	376	420	467
OTHER VARIABLE EXPENSES										
VARIABLE LABOUR COST										
CHEMICAL AND OTHER COST										
TRANSPORT COST										
OTHER VARIABLE EXPENSES										
TOTAL VARIABLE COSTS					204	274	341	376	420	467

```
FIXED OPERATING LABOUR COSTS
FIXED SUPERVISORY LABOUR COSTS
MAINTENANCE MATERIALS COST                                        365      393      421      450      482      517
FIXED ADMINISTRATIVE LABOUR CO
ADMINISTRATIVE COST
PROPERTY TAX
INSURANCE COSTS                                                    23       24       25       27       28       30
OTHER FIXED COST
                               ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL FIXED COSTS                                                 388      417      446      477      511      546
                               ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL OPERATING COSTS                                             592      691      787      656      931    1,013
                               ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
NET OPERATING MARGIN                                             (340)    (345)    (333)    (350)    (369)    (388)

CAPITALIZATION
--------------
PRIVATE EQUITY
TOTAL CAPITAL                   4,398



ECONOMIC ANALYSIS
-----------------
NPV NET OPERATING MARGIN       (4,478)
PROJECT IRR TO TOTAL CAPITAL     (1.00)
SIMPLE PAYBACK YEARS
DISCOUNTED PAYBACK YEARS
```

```
                                               LEVELIZED COSTS OF PROJECT
                                               --------------------------

STEAM LEVELIZED COST                879.53

LEVELIZED BYPRODUCT CREDIT           98.64
LEVELIZED FEEDSTOCK COST            116.13
LEVELIZED O AND M COST              144.95
LEVELIZED CAPITAL COST              717.09

                                                   CAPITAL RECOVERY
                                                   ----------------

ANNUAL CAPITAL RECOVERY FACTOR         .20
AVERAGE PRICE MULTIPLIER              2.02
STEAM REQUIRED PRICE                412.57
```

RETURN ON TOTAL CAPITA
PROJECT INCOME STATEMEN
CAT LAKE ELECTRIFICATIO
THOUSANDS OF DOLLARS

	1994	1995	1996	1997	1998	1999	2000	2001	2002
PRODUCT PRICES									
STEAM PRICE	112,59	122.78	132.24	142,42	153.39	165.20	177.92	191.62	206.37
ELECTRICITY PRICE	1,04	1.13	1.22	1.31	1.41	1.52	1.64	1.76	1.90
OTHER PRODUCT PRICE	.24	.26	.28	.31	.33	.36	.38	.41	.44
REVENUES									
STEAM REVENUE	261	285	307	331	357	385	415	447	481
ELECTRICITY REVENUE	256	287	317	350	387	426	470	506	545
OTHER PRODUCT REVENUE	177	198	220	245	271	301	331	356	384
TOTAL REVENUES	694	770	844	926	1,015	1,112	1,216	1,309	1,410
VARIABLE COSTS									
MILL WASTE COST	294	322	350	379	412	446	483	520	560
OTHER FEEDSTOCK COST	226	255	284	315	356	394	434	467	503
TOTAL FEEDSTOCK COSTS	520	578	633	694	768	840	917	987	1,064
OTHER VARIABLE EXPENSES									
VARIABLE LABOUR COST									
CHEMICAL AND OTHER COST									
TRANSPORT COST									
OTHER VARIABLE EXPENSES									
TOTAL VARIABLE COSTS	520	578	633	694	768	840	917	987	1,064

FIXED OPERATING LABOUR COSTS									
FIXED SUPERVISORY LABOUR COSTS									
MAINTENANCE MATERIALS COST	553	593	635	680	720	780	835	895	958
FIXED ADMINISTRATIVE LABOUR CO									
ADMINISTRATIVE COST									
PROPERTY TAX									
INSURANCE COSTS	31	33	34	36	38	40	42	44	46
OTHER FIXED COST									
	-------	--------	--------	--------	--------	--------	--------	--------	--------
TOTAL FIXED COSTS	584	625	669	716	766	819	877	938	1,004
	-------	--------	--------	--------	--------	--------	--------	--------	--------
TOTAL OPERATING COSTS	1,104	1,203	1,302	1,409	1,533	1,660	1,794	1,926	2,067
	-------	--------	--------	--------	--------	--------	--------	--------	--------
NET OPERATING MARGIN	(410)	(433)	(468)	(484)	(510)	(547)	(578)	(616)	(657)

Cat Lake
Gasifier
100 Amps

```
INPUT: NORECORD
READY FOR MODELING LANGUAGE COMMAND
INPUT: SOLVE
EMPTY EXPRESSION
ERROR IN LINE 144 OF DATAFILE
EMPTY EXPRESSION
ERROR IN LINE 146 OF DATAFILE
MODEL CLINT  VERSION OF  03/29/84  09:31 -- 19 COLUMNS 338 VARIABLES
ENTER SOLVE OPTIONS
INPUT: GENREPORT TOTAL

                                                  PROJECT STATISTICS
                                               CAT LAKE ELECTRIFICATION

                                                     OUTPUT DATA
                                                     -----------

STEAM ANNUAL OUTPUT                          0

                                                     INPUT DATA
                                                     ----------

MILL WASTE ANNUAL CONSUMPTION                0

                                               BASE YEAR VARIABLE COSTS
                                               ------------------------

CHEMICAL AND OTHER COSTS                     0
VARIABLE LABOUR COSTS                        0
TRANSPORT COSTS                              0
OTHER VARIABLE COSTS                         0

                                                BASE YEAR FIXED COSTS
                                                ---------------------

FIXED LABOUR                                 0
FIXED SUPERVISORY LABOUR                     0
FIXED ADMINISTRATIVE LABOUR                  0
OTHER ADMINISTRATIVE COSTS                   0
MAINTENANCE AND MATERIALS COSTS        272,300
PROPERTY TAXES                               0
INSURANCE COST                          27,000
OTHER FIXED COSTS                            0
```

```
                                              CAPITAL COST ESTIMATES

                                               BASE YEAR ESTIMATE
                                               ------------------
                              1984    1985     1986     1987
                             ------  -------  -------  -------
LAND COST                                      2,714    2,714
EQUIPMENT CLASS A
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT

                                           INSERVICE COST BREAKDOWN
                                           ------------------------
LAND COST                                      3,142    3,381
EQUIPMENT CLASS A
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT
TOTAL ANNUAL CAP COST                          3,142    3,381
CUMULATIVE CAPITAL COST                        3,142    6,523

                                                INSERVICE COSTS
                                                ---------------
CONSTRUCTION OUTLAY                            3,142    3,381
INTEREST ON CONSTRUCTION
WORKING CAPITAL
TOTAL INSERVICE COST                           3,142    3,381
```

INFLATION RATES
(% INCREASE OVER PREVIOUS YEAR)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
REVENUE ESCALATORS															

STEAM INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
ELECTRICITY INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER PRODUCT INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
FEEDSTOCK INFLATORS															

MILL WASTE INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER FEEDSTOCK INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
GENERAL PRICE INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
FOSSIL FUEL INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
LABOUR INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
TRANSPORT INFLATOR	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800

```
                                        PROJECT STATISTICS
                                      CAT LAKE ELECTRIFICATION

                             2001    2002
                             ----    ----
REVENUE ESCALATORS
------------------
STEAM INFLATOR              .0770   .0770
ELECTRICITY INFLATOR        .0770   .0770
OTHER PRODUCT INFLATOR      .0770   .0770

FEEDSTOCK INFLATORS
-------------------
MILL WASTE INFLATOR         .0770   .0770
OTHER FEEDSTOCK INFLATOR    .0770   .0770

GENERAL PRICE INFLATOR      .0710   .0710

FOSSIL FUEL INFLATOR        .0770   .0770
LABOUR INFLATOR             .0710   .0710
TRANSPORT INFLATOR          .0800   .0800
```

INPUT: GENREPORT INCOMP

RETURN ON TOTAL CAPITA.
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCT PRICES										
STEAM PRICE	48.00	52.22	56.82	61.82	67.26	73.18	79.62	86.82	94.00	103.26
ELECTRICITY PRICE	.44	.48	.52	.57	.62	.67	.73	.80	.87	.95
OTHER PRODUCT PRICE	.10	.11	.12	.13	.14	.16	.17	.19	.20	.22
REVENUES										
STEAM REVENUE					52	113	184	201	219	239
ELECTRICITY REVENUE					184	218	257	289	324	363
OTHER PRODUCT REVENUE					223	255	289	327	369	417
TOTAL REVENUES					459	586	730	816	912	1,019
VARIABLE COSTS										
MILL WASTE COST					175	218	260	286	313	346
OTHER FEEDSTOCK COST					248	289	336	386	436	487
TOTAL FEEDSTOCK COSTS					422	507	597	672	746	832
OTHER VARIABLE EXPENSES										
VARIABLE LABOUR COST										
CHEMICAL AND OTHER COST										
TRANSPORT COST										
OTHER VARIABLE EXPENSES										
TOTAL VARIABLE COSTS					422	507	597	672	746	832

FIXED OPERATING LABOUR COSTS										
FIXED SUPERVISORY LABOUR COSTS										
MAINTENANCE MATERIALS COST					365	393	421	450	482	517
FIXED ADMINISTRATIVE LABOUR CO										
ADMINISTRATIVE COST										
PROPERTY TAX										
INSURANCE COSTS					33	34	36	38	40	42
OTHER FIXED COST										
	------	-------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL FIXED COSTS					398	427	457	488	522	559
	------	-------	-------	-------	-------	-------	-------	-------	-------	-------
TOTAL OPERATING COSTS					620	934	1,063	1,160	1,264	1,340
	------	-------	-------	-------	-------	-------	-------	-------	-------	-------
NET OPERATING MARGIN					(362)	(348)	(324)	(344)	(357)	(371)

CAPITALIZATION

PRIVATE EQUITY
TOTAL CAPITAL 6,523

ECONOMIC ANALYSIS

NPV NET OPERATING MARGIN	(5,918)
PROJECT IRR TO TOTAL CAPITAL	(1.00)
SIMPLE PAYBACK YEARS	
DISCOUNTED PAYBACK YEARS	

```
                                        LEVELIZED COSTS OF PROJECT
                                        --------------------------

STEAM LEVELIZED COST           1034.52

LEVELIZED BYPRODUCT CREDIT      199.80
LEVELIZED FEEDSTOCK COST        211.09
LEVELIZED O AND M COST          148.28
LEVELIZED CAPITAL COST          874.94



                                           CAPITAL RECOVERY
                                           ----------------

ANNUAL CAPITAL RECOVERY FACTOR      .20
AVERAGE PRICE MULTIPLIER           1.73
STEAM REQUIRED PRICE             352.19
```

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION

THOUSANDS OF DOLLARS

	1994	1995	1996	1997	1998	1999	2000	2001	2002
PRODUCT PRICES									
STEAM PRICE	112.59	122.78	132.24	142.42	153.39	165.20	177.92	191.62	206.37
ELECTRICITY PRICE	1.04	1.13	1.22	1.31	1.41	1.52	1.64	1.76	1.90
OTHER PRODUCT PRICE	.24	.26	.28	.31	.33	.36	.38	.41	.44
REVENUES									
STEAM REVENUE	261	285	307	331	357	385	415	447	481
ELECTRICITY REVENUE	407	456	504	557	615	678	749	806	868
OTHER PRODUCT REVENUE	470	525	584	648	719	797	877	944	1,017
TOTAL REVENUES	1,138	1,266	1,395	1,536	1,691	1,860	2,040	2,197	2,366
VARIABLE COSTS									
MILL WASTE COST	381	415	450	487	528	571	615	663	714
OTHER FEEDSTOCK COST	549	619	688	756	847	936	1,031	1,111	1,196
TOTAL FEEDSTOCK COSTS	930	1,033	1,137	1,243	1,375	1,507	1,647	1,773	1,910
OTHER VARIABLE EXPENSES									
VARIABLE LABOUR COST									
CHEMICAL AND OTHER COST									
TRANSPORT COST									
OTHER VARIABLE EXPENSES									
TOTAL VARIABLE COSTS	930	1,033	1,137	1,243	1,375	1,507	1,647	1,773	1,910

FIXED OPERATING LABOUR COSTS									
FIXED SUPERVISORY LABOUR COSTS									
MAINTENANCE MATERIALS COST	553	593	635	680	728	780	835	895	958
FIXED ADMINISTRATIVE LABOUR CO									
ADMINISTRATIVE COST									
PROPERTY TAX									
INSURANCE COSTS	44	46	48	51	53	56	59	62	65
OTHER FIXED COST									
TOTAL FIXED COSTS	597	639	683	731	782	836	894	956	1,023
TOTAL OPERATING COSTS	1,527	1,672	1,821	1,974	2,157	2,343	2,541	2,730	2,933
NET OPERATING MARGIN	(389)	(406)	(426)	(438)	(466)	(483)	(501)	(532)	(566)

```
INPUT: QUIT
READY FOR MODELLING LANGUAGE COMMAND
INPUT: SOLVE
EMPTY EXPRESSION
ERROR IN LINE 144 OF DATAFILE
EMPTY EXPRESSION
ERROR IN LINE 146 OF DATAFILE
MODEL CLINT  VERSION OF  03/29/84  09:31 -- 19 COLUMNS 338 VARIABLES
ENTER SOLVE OPTIONS
INPUT: GEOREPORT TOTAL

                                          PROJECT STATISTICS
                                       CAT LAKE ELECTRIFICATION

                                             OUTPUT DATA
                                             -----------

   STEAM ANNUAL OUTPUT                    0

                                             INPUT DATA
                                             ----------

   MILL WASTE ANNUAL CONSUMPTION          0

                                       BASE YEAR VARIABLE COSTS
                                       ------------------------

   CHEMICAL AND OTHER COSTS               0
   VARIABLE LABOUR COSTS                  0
   TRANSPORT COSTS                        0
   OTHER VARIABLE COSTS                   0

                                        BASE YEAR FIXED COSTS
                                        ---------------------

   FIXED LABOUR                           0
   FIXED SUPERVISORY LABOUR               0
   FIXED ADMINISTRATIVE LABOUR            0
   OTHER ADMINISTRATIVE COSTS             0
   MAINTENANCE AND MATERIALS COSTS  297,300
   PROPERTY TAXES                         0
   INSURANCE COST                    16,886
   OTHER FIXED COSTS                      0
```

Cat Lake
Steam Engine
20 Amp

```
                                            CAPITAL COST ESTIMATES

                                             BASE YEAR ESTIMATE
                                             ==================
                                  1984     1985     1986     1987
                                 ------  -------  -------  -------
LAND COST
EQUIPMENT CLASS A                                   1,016    1,016
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT

                                           INSERVICE COST BREAKDOWN
                                           ========================
LAND COST
EQUIPMENT CLASS A                                   1,870    2,013
EQUIPMENT CLASS B
EQUIPMENT CLASS C
EQUIPMENT CLASS D
ENGINEERING AND PROJECT MGMT
TOTAL ANNUAL CAP COST                               1,870    2,013
CUMULATIVE CAPITAL COST                             1,870    3,883

                                              INSERVICE COSTS
                                              ===============

CONSTRUCTION OUTLAY                                 1,870    2,013
INTEREST ON CONSTRUCTION
WORKING CAPITAL
TOTAL INSERVICE COST                                1,870    2,013
```

INFLATION RATES
(% INCREASE OVER PREVIOUS YEAR)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
REVENUE ESCALATORS															

STEAM INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
ELECTRICITY INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER PRODUCT INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
FEEDSTOCK INFLATORS															

MILL WASTE INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
GENERAL PRICE INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
FOSSIL FUEL INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
LABOUR INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
TRANSPORT INFLATOR	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800

PROJECT STATISTICS
CAT LAKE ELECTRIFICATION

	2001	2002
REVENUE ESCALATORS		
STEAM INFLATION	.0770	.0770
ELECTRICITY INFLATOR	.0770	.0770
OTHER PRODUCT INFLATOR	.0770	.0770
FEEDSTOCK INFLATORS		
MILL WASTE INFLATOR	.0770	.0770
GENERAL PRICE INFLATOR	.0710	.0710
FOSSIL FUEL INFLATOR	.0770	.0770
LABOUR INFLATOR	.0710	.0710
TRANSPORT INFLATOR	.0800	.0800

```
INPUT:
INPUT: GENREPORT INCOME

                              RETURN ON TOTAL CAPITAL
                              PROJECT INCOME STATEMENT
                              CAT LAKE ELECTRIFICATION
                               THOUSANDS OF DOLLARS

                      1984    1985    1986    1987    1988    1989    1990    1991    1992    1993
                    ------  ------- ------- ------- ------- ------- ------- ------- ------- -------

PRODUCT PRICES
--------------       46.00   52.22   56.82   61.82   67.20   73.18   79.62   86.82   94.08  103.25
STEAM PRICE            .44     .48     .52     .57     .62     .67     .73     .80     .87     .95
ELECTRICITY PRICE      .10     .11     .12     .13     .14     .16     .17     .19     .20     .22
OTHER PRODUCT PRICE

REVENUES
--------                                                52     113     184     201     219     239
STEAM REVENUE                                          115     137     161     181     204     228
ELECTRICITY REVENUE                                     84      96     109     123     139     157
OTHER PRODUCT REVENUE ------  ------- ------- ------- ------- ------- ------- ------- ------- -------
                                                       251     346     454     505     562     625
TOTAL REVENUES


VARIABLE COSTS
--------------                                         116     165     217     237     262     289
MILL WASTE COST                                    ------- ------- ------- ------- ------- -------
                    ------  ------- ------- ------- 116     165     217     237     262     289
TOTAL FEEDSTOCK COSTS

OTHER VARIABLE EXPENSES
-----------------------
VARIABLE LABOUR COST
CHEMICAL AND OTHER COST
TRANSPORT COST      ------  ------- ------- ------- ------- ------- ------- ------- ------- -------

OTHER VARIABLE EXPENSES                            ------- ------- ------- ------- ------- -------
                    ------  ------- ------- ------- 116     165     217     237     262     289
TOTAL VARIABLE COSTS
```

```
FIXED OPERATING LABOUR COSTS
FIXED SUPERVISORY LABOUR COSTS
MAINTENANCE MATERIALS COST                                                 399      429      459      492      527      564
FIXED ADMINISTRATIVE LABOUR CO
ADMINISTRATIVE COST
PROPERTY TAX
INSURANCE COSTS                                                             20       21       22       23       24       26
OTHER FIXED COST
                            ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL FIXED COSTS                                                          418      450      481      515      551      590
                            ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL OPERATING COSTS                                                      536      615      698      752      813      879
                            ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
NET OPERATING MARGIN                                                     (265)    (269)    (288)    (247)    (251)    (258)

CAPITALIZATION



--------------
PRIVATE EQUITY
TOTAL CAPITAL                  3,803

ECONOMIC ANALYSIS
-----------------
NPV NET OPERATING MARGIN     (3,642)
PROJECT IRR TO TOTAL CAPITAL   (1,00)
SIMPLE PAYBACK YEARS
DISCOUNTED PAYBACK YEARS
```

```
                                          LEVELIZED COSTS OF PROJECT
                                          --------------------------

   STEAM LEVELIZED COST               695.07

   LEVELIZED BYPRODUCT CREDIT          96.04
   LEVELIZED FEEDSTOCK COST            70.28
   LEVELIZED O AND M COST             150.46
   LEVELIZED CAPITAL COST             566.47



                                             CAPITAL RECOVERY
                                             ----------------

    ANNUAL CAPITAL RECOVERY FACTOR       .20
    AVERAGE PRICE MULTIPLIER            1.70
    STEAM REQUIRED PRICE              345.96
```

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION

THOUSANDS OF DOLLARS

	1994	1995	1996	1997	1998	1999	2000	2001	2002
PRODUCT PRICES									
STEAM PRICE	112.59	122.78	132.24	142.42	153.39	165.20	177.92	191.62	206.37
ELECTRICITY PRICE	1.04	1.13	1.22	1.31	1.41	1.52	1.64	1.76	1.90
OTHER PRODUCT PRICE	.24	.26	.28	.31	.33	.36	.38	.41	.44
REVENUES									
STEAM REVENUE	261	285	307	331	357	385	415	447	481
ELECTRICITY REVENUE	256	287	317	350	387	426	470	506	545
OTHER PRODUCT REVENUE	177	198	220	245	271	301	331	356	384
TOTAL REVENUES	694	770	844	926	1,015	1,112	1,216	1,309	1,410
VARIABLE COSTS									
MILL WASTE COST	318	349	380	411	448	487	528	569	612
TOTAL FEEDSTOCK COSTS	318	349	380	411	448	487	528	569	612
OTHER VARIABLE EXPENSES									
VARIABLE LABOUR COST									
CHEMICAL AND OTHER COST									
TRANSPORT COST									
OTHER VARIABLE EXPENSES									
TOTAL VARIABLE COSTS	318	349	380	411	448	487	528	569	612

FIXED OPERATING LABOUR COSTS									
FIXED SUPERVISORY LABOUR COSTS									
MAINTENANCE MATERIALS COST	604	647	693	742	795	851	912	977	1,046
FIXED ADMINISTRATIVE LABOUR CO									
ADMINISTRATIVE COST									
PROPERTY TAX									
INSURANCE COSTS	27	28	30	31	33	34	36	38	40
OTHER FIXED COST									
	-------	--------	--------	--------	--------	--------	--------	--------	--------
TOTAL FIXED COSTS	631	675	723	773	826	886	948	1,014	1,086
	-------	--------	--------	--------	--------	--------	--------	--------	--------
TOTAL OPERATING COSTS	949	1,025	1,103	1,185	1,275	1,373	1,476	1,583	1,698
	-------	--------	--------	--------	--------	--------	--------	--------	--------
NET OPERATING MARGIN	(254)	(255)	(259)	(259)	(260)	(261)	(268)	(274)	(288)

CAT LAKE
STEAM ENGINE
100 AMPS

```
INPUT: NORECORD
READY FOR MODELING LANGUAGE COMMAND
INPUT: SOLVE
EMPTY EXPRESSION
ERROR IN LINE 144 OF DATAFILE
EMPTY EXPRESSION
ERROR IN LINE 146 OF DATAFILE
UNDEFINED VARIABLE O
MODEL CLINT  VERSION OF  03/29/84  09:31 -- 19 COLUMNS 339 VARIABLES
ERROR(S) SHOULD BE CORRECTED
INPUT: SOLVE
ENTER SOLVE OPTIONS
INPUT: GENREPORT TOTAL

                                                    PROJECT STATISTICS
                                                 CAT LAKE ELECTRIFICATION

                                                       OUTPUT DATA
                                                       -----------

STEAM ANNUAL OUTPUT                           0

                                                        INPUT DATA
                                                        ----------

MILL WASTE ANNUAL CONSUMPTION

                                                 BASE YEAR VARIABLE COSTS
                                                 ------------------------
CHEMICAL AND OTHER COSTS                      0
VARIABLE LABOUR COSTS                         0
TRANSPORT COSTS                               0
OTHER VARIABLE COSTS                          0

                                                   BASE YEAR FIXED COSTS
                                                   ---------------------

FIXED LABOUR                                  0
FIXED SUPERVISORY LABOUR                      0
FIXED ADMINISTRATIVE LABOUR                   0
OTHER ADMINISTRATIVE COSTS                    0
MAINTENANCE AND MATERIALS COSTS         297,300
PROPERTY TAXES                                0
INSURANCE COST                           18,700



OTHER FIXED COSTS                             0
```

```
                                         CAPITAL COST ESTIMATES

                                          BASE YEAR ESTIMATE
                                          ------------------
                                1984    1985     1986    1987
                              ------- ------- ------- -------
 LAND COST
 EQUIPMENT CLASS A                               1,803   1,803
 EQUIPMENT CLASS B
 EQUIPMENT CLASS C
 EQUIPMENT CLASS D
 ENGINEERING AND PROJECT MGMT

                                         INSERVICE COST BREAKDOWN
                                         ------------------------
 LAND COST
 EQUIPMENT CLASS A                               2,087   2,246
 EQUIPMENT CLASS B
 EQUIPMENT CLASS C
 EQUIPMENT CLASS D
 ENGINEERING AND PROJECT MGMT
 TOTAL ANNUAL CAP COST                           2,087   2,246
 CUMULATIVE CAPITAL COST                         2,087   4,334



                                            INSERVICE COSTS
                                            ---------------

 CONSTRUCTION OUTLAY                             2,087   2,246
 INTEREST ON CONSTRUCTION
 WORKING CAPITAL
 TOTAL INSERVICE COST                            2,087   2,246
```

INFLATION RATES
(% INCREASE OVER PREVIOUS YEAR)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
REVENUE ESCALATORS															
STEAM INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
ELECTRICITY INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER PRODUCT INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
FEEDSTOCK INFLATORS															
MILL WASTE INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
GENERAL PRICE INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
FOSSIL FUEL INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
LABOUR INFLATOR	.0760	.0760	.0760	.0760	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
TRANSPORT INFLATOR	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800

```
                                        PROJECT STATISTICS
                                      CAT LAKE ELECTRIFICATION

                               2001   2002
                               ----   ----
REVENUE ESCALATORS
------------------
STEAM INFLATOR                .0770  .0770
ELECTRICITY INFLATOR          .0770  .0770
OTHER PRODUCT INFLATOR        .0770  .0770

FEEDSTOCK INFLATORS



------------------
MILL WASTE INFLATOR           .0770  .0770

GENERAL PRICE INFLATOR        .0710  .0710

FOSSIL FUEL INFLATOR          .0770  .0770
LABOUR INFLATOR               .0710  .0710
TRANSPORT INFLATOR            .0800  .0800
```

INPUT: GENREPORT INCOME

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCT PRICES										
STEAM PRICE	48,00	52,22	56,82	61,82	67,26	73,18	79,62	86,62	94,68	103,25
ELECTRICITY PRICE	.44	.48	.52	.57	.62	.67	.73	.80	.87	.95
OTHER PRODUCT PRICE	.10	.11	.12	.13	.14	.16	.17	.19	.20	.22
REVENUES										
STEAM REVENUE					52	113	184	201	219	239
ELECTRICITY REVENUE					184	218	257	269	324	363
OTHER PRODUCT REVENUE					223	255	289	327	369	417
TOTAL REVENUES					459	586	730	816	912	1,019
VARIABLE COSTS										
MILL WASTE COST					192	234	273	298	328	359
TOTAL FEEDSTOCK COSTS					192	234	273	298	328	359
OTHER VARIABLE EXPENSES										
VARIABLE LABOUR COST										
CHEMICAL AND OTHER COST										
TRANSPORT COST										
OTHER VARIABLE EXPENSES										
TOTAL VARIABLE COSTS					192	234	273	298	328	359

```
FIXED OPERATING LABOUR COSTS                                                        564
FIXED SUPERVISORY LABOUR COSTS                          399     429     459     492     527
MAINTENANCE MATERIALS COST
FIXED ADMINISTRATIVE LABOUR CO
ADMINISTRATIVE COST                                                                       29
PROPERTY TAX                                             23      24      25      26      28
INSURANCE COSTS                                                                -------  -------
OTHER FIXED COST               ------ ------- ------- ------- ------- ------- -------     554     593
                                                        421     453     484     518  -------  -------
TOTAL FIXED COSTS              ------ ------- ------- ------- ------- ------- ------- -------     882     952
                                                        613     686     757     818  -------  -------
TOTAL OPERATING COSTS          ------ ------- ------- ------- ------- ------- -------               30      67
                                                      (155)   (100)    (27)
NET OPERATING MARGIN

CAPITALIZATION
==============
PRIVATE EQUITY
TOTAL CAPITAL                  4,334

ECONOMIC ANALYSIS
=================
NPV NET OPERATING MARGIN      (2,868)
PROJECT IRR TO TOTAL CAPITAL   (1.00)
SIMPLE PAYBACK YEARS
DISCOUNTED PAYBACK YEARS
```

```
                                        LEVELIZED COSTS OF PROJECT
                                        --------------------------

STEAM LEVELIZED COST              422.18

LEVELIZED BYPRODUCT CREDIT        199.80
LEVELIZED FEEDSTOCK COST           90.54
LEVELIZED O AND M COST            157.40
LEVELIZED CAPITAL COST            374.03

                                          CAPITAL RECOVERY
                                          ----------------

ANNUAL CAPITAL RECOVERY FACTOR       .20
AVERAGE PRICE MULTIPLIER            1.09
STEAM REQUIRED PRICE              223.19
```

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT
CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1994	1995	1996	1997	1998	1999	2000	2001	2002
PRODUCT PRICES									
STEAM PRICE	112.59	122.78	132.24	142.42	153.39	165.20	177.92	191.62	206.37
ELECTRICITY PRICE	1.04	1.13	1.22	1.31	1.41	1.52	1.64	1.76	1.90
OTHER PRODUCT PRICE	.24	.26	.28	.31	.33	.36	.38	.41	.44
REVENUES									
STEAM REVENUE	261	285	307	331	357	385	415	447	481
ELECTRICITY REVENUE	407	456	504	557	615	678	749	806	808
OTHER PRODUCT REVENUE	470	525	584	648	719	797	877	944	1,017
TOTAL REVENUES	1,138	1,266	1,395	1,536	1,691	1,860	2,040	2,197	2,306
VARIABLE COSTS									
MILL WASTE COST	393	431	463	497	541	580	627	675	727
TOTAL FEEDSTOCK COSTS	393	431	463	497	541	580	627	675	727
OTHER VARIABLE EXPENSES									
VARIABLE LABOUR COST									
CHEMICAL AND OTHER COST									
TRANSPORT COST									
OTHER VARIABLE EXPENSES									
TOTAL VARIABLE COSTS	393	431	463	497	541	580	627	675	727

FIXED OPERATING LABOUR COSTS									
FIXED SUPERVISORY LABOUR COSTS									
MAINTENANCE MATERIALS COST	604	647	693	742	795	851	912	977	1,046
FIXED ADMINISTRATIVE LABOUR CO									
ADMINISTRATIVE COST									
PROPERTY TAX									
INSURANCE COSTS	30	32	34	35	37	39	41	43	45
OTHER FIXED COST									
TOTAL FIXED COSTS	635	679	727	778	832	890	953	1,019	1,091
TOTAL OPERATING COSTS	1,027	1,111	1,190	1,275	1,373	1,470	1,579	1,695	1,816
NET OPERATING MARGIN	111	155	205	261	318	390	461	563	548

CAT LAKE
100 Amp
STEAM ENGINE
No Local Labour Cos

```
INPUT: NORECORD
READY FOR MODELING LANGUAGE COMMAND
INPUT: SOLVE
ENTER SOLVE OPTIONS
INPUT: GENREPORT TOTAL

                                      PROJECT STATISTICS
                                   CAT LAKE ELECTRIFICATION

                                         OUTPUT DATA
                                         -----------

STEAM ANNUAL OUTPUT                   0

                                          INPUT DATA
                                          ----------

MILL WASTE ANNUAL CONSUMPTION         0

                                  BASE YEAR VARIABLE COSTS
                                  ------------------------

CHEMICAL AND OTHER COSTS              0
VARIABLE LABOUR COSTS                 0
TRANSPORT COSTS                       0
OTHER VARIABLE COSTS                  0

                                   BASE YEAR FIXED COSTS
                                   ---------------------

FIXED LABOUR                          0
FIXED SUPERVISORY LABOUR              0
FIXED ADMINISTRATIVE LABOUR           0
OTHER ADMINISTRATIVE COSTS            0
MAINTENANCE AND MATERIALS COSTS  57,500
PROPERTY TAXES                        0
INSURANCE COST                   18,700
OTHER FIXED COSTS                     0
```

```
                                        CAPITAL COST ESTIMATES

                                          BASE YEAR ESTIMATE
                                          ------------------
                              1984     1985     1986     1987
                             ------  -------  -------  -------
    LAND COST
    EQUIPMENT CLASS A                          1,603    1,603
    EQUIPMENT CLASS B
    EQUIPMENT CLASS C
    EQUIPMENT CLASS D
    ENGINEERING AND PROJECT MGMT

                                       INSERVICE COST BREAKDOWN
                                       ------------------------

    LAND COST
    EQUIPMENT CLASS A                          2,087    2,246
    EQUIPMENT CLASS B
    EQUIPMENT CLASS C
    EQUIPMENT CLASS D
    ENGINEERING AND PROJECT MGMT
    TOTAL ANNUAL CAP COST                      2,087    2,246
    CUMULATIVE CAPITAL COST                    2,087    4,333

                                          INSERVICE COSTS
                                          ---------------

    CONSTRUCTION OUTLAY                        2,087    2,246
    INTEREST ON CONSTRUCTION
    WORKING CAPITAL
    TOTAL INSERVICE COST                       2,087    2,246
```

INFLATION RATES
(% INCREASE OVER PREVIOUS YEAR)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
REVENUE ESCALATORS															
STEAM INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
ELECTRICITY INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
OTHER PRODUCT INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
FEEDSTOCK INFLATORS															
MILL WASTE INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
GENERAL PRICE INFLATOR	.0700	.0700	.0700	.0700	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
FOSSIL FUEL INFLATOR	.0880	.0880	.0880	.0880	.0880	.0905	.0905	.0905	.0905	.0905	.0770	.0770	.0770	.0770	.0770
LABOUR INFLATOR	.0700	.0700	.0700	.0700	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710	.0710
TRANSPORT INFLATOR	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800	.0800

```
                                   PROJECT STATISTICS
                               CAT LAKE ELECTRIFICATION

                             2001   2002
                             ----   ----
REVENUE ESCALATORS
------------------
STEAM INFLATION             .0770  .0770
ELECTRICITY INFLATION       .0770  .0770
OTHER PRODUCT INFLATION     .0770  .0770

FEEDSTOCK INFLATIONS
--------------------
MILL WASTE INFLATION        .0770  .0770

GENERAL PRICE INFLATOR      .0710  .0710

FOSSIL FUEL INFLATOR        .0770  .0770
LABOUR INFLATION            .0710  .0710
TRANSPORT INFLATION         .0800  .0800
```

```
INPUT:
INPUT: GENREPORT INCOME

                                       RETURN ON TOTAL CAPITAL
                                      PROJECT INCOME STATEMENT
                                      CAT LAKE ELECTRIFICATION
                                        THOUSANDS OF DOLLARS

                              1984    1985    1986    1987    1988    1989    1990    1991    1992    1993
                             ------ ------- ------- ------- ------- ------- ------- ------- ------- -------
 PRODUCT PRICES
 --------------
 STEAM PRICE                 48.00   52.22   56.82   61.82   67.26   73.18   79.62   86.82   94.68  103.25
 ELECTRICITY PRICE             .44     .48     .52     .57     .62     .67     .73     .80     .87     .95
 OTHER PRODUCT PRICE           .10     .11     .12     .13     .14     .16     .17     .19     .20     .22

 REVENUES
 --------
 STEAM REVENUE                                                  52     113     184     201     219     239
 ELECTRICITY REVENUE                                           184     218     257     289     324     363
 OTHER PRODUCT REVENUE                                         223     255     289     327     369     417
                             ------ ------- ------- ------- ------- ------- ------- ------- ------- -------

 TOTAL REVENUES                                                459     586     730     816     912   1,019

 VARIABLE COSTS
 --------------
 MILL WASTE COST                                               192     234     273     298     328     359
                             ------ ------- ------- ------- ------- ------- ------- ------- ------- -------
 TOTAL FEEDSTOCK COSTS                                         192     234     273     298     328     359

 OTHER VARIABLE EXPENSES
 -----------------------
 VARIABLE LABOUR COST
 CHEMICAL AND OTHER COST
 TRANSPORT COST
                             ------ ------- ------- ------- ------- ------- ------- ------- ------- -------
 OTHER VARIABLE EXPENSES
                             ------ ------- ------- ------- ------- ------- ------- ------- ------- -------
 TOTAL VARIABLE COSTS                                          192     234     273     298     328     359
```

```
FIXED OPERATING LABOUR COSTS
FIXED SUPERVISORY LABOUR COSTS
MAINTENANCE MATERIALS COST                                          77      83      89      95     102     108
FIXED ADMINISTRATIVE LABOUR CO
ADMINISTRATIVE COST
PROPERTY TAX
INSURANCE COSTS                                                     23      24      25      26      28      29
OTHER FIXED COST
                                ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL FIXED COSTS                                                  100     107     114     121     130     138
                                ------  -------  -------  -------  -------  -------  -------  -------  -------  -------
TOTAL OPERATING COSTS                                              292     340     387     419     457     497
                                ======  =======  =======  =======  =======  =======  =======  =======  =======  =======
NET OPERATING MARGIN                                               167     246     343     397     455     522


CAPITALIZATION
--------------
PRIVATE EQUITY
TOTAL CAPITAL                   4,339

ECONOMIC ANALYSIS
-----------------
NPV NET OPERATING MARGIN       (1,335)
PROJECT IRR TO TOTAL CAPITAL      .09
SIMPLE PAYBACK YEARS             9.45
DISCOUNTED PAYBACK YEARS
```

```
                                  LEVELIZED COSTS OF PROJECT
                                  --------------------------

   STEAM LEVELIZED COST                261.09

   LEVELIZED BYPRODUCT CREDIT          199.80
   LEVELIZED FEEDSTOCK COST             90.54
   LEVELIZED O AND M COST               36.72
   LEVELIZED CAPITAL COST              333.62



                                        CAPITAL RECOVERY
                                        ----------------

   ANNUAL CAPITAL RECOVERY FACTOR         .20
   AVERAGE PRICE MULTIPLIER               .74
   STEAM REQUIRED PRICE                149.61
```

RETURN ON TOTAL CAPITAL
PROJECT INCOME STATEMENT

CAT LAKE ELECTRIFICATION
THOUSANDS OF DOLLARS

	1994	1995	1996	1997	1998	1999	2000	2001	2002
PRODUCT PRICES									
STEAM PRICE	112.59	122.78	132.24	142.42	153.39	165.20	177.92	191.62	206.37
ELECTRICITY PRICE	1.04	1.13	1.22	1.31	1.41	1.52	1.64	1.76	1.90
OTHER PRODUCT PRICE	.24	.26	.28	.31	.33	.36	.38	.41	.44
REVENUES									
STEAM REVENUE	261	285	307	331	357	385	415	447	481
ELECTRICITY REVENUE	407	456	504	557	615	678	749	806	868
OTHER PRODUCT REVENUE	470	525	584	648	719	797	877	944	1,017
TOTAL REVENUES	1,138	1,266	1,395	1,536	1,691	1,860	2,040	2,197	2,366
VARIABLE COSTS									
MILL WASTE COST	343	431	463	497	541	580	627	675	727
TOTAL FEEDSTOCK COSTS	343	431	463	497	541	580	627	675	727
OTHER VARIABLE EXPENSES									
VARIABLE LABOUR COST									
CHEMICAL AND OTHER COST									
TRANSPORT COST									
OTHER VARIABLE EXPENSES									
TOTAL VARIABLE COSTS	343	431	463	497	541	580	627	675	727

```
FIXED OPERATING LABOUR COSTS
FIXED SUPERVISORY LABOUR COSTS
MAINTENANCE MATERIALS COST          117     125     134     144     154     165     176     189     202
FIXED ADMINISTRATIVE LABOUR CO
ADMINISTRATIVE COST
PROPERTY TAX
INSURANCE COSTS                      30      32      34      35      37      39      41      43      45
OTHER FIXED COST
                                 ------ ------- ------- ------- ------- ------- ------- ------- -------
TOTAL FIXED COSTS                   147     157     168     179     191     204     217     232     247
                                 ------ ------- ------- ------- ------- ------- ------- ------- -------
TOTAL OPERATING COSTS               540     589     631     676     732     783     844     907     974
                                 ====== ======= ======= ======= ======= ======= ======= ======= =======
NET OPERATING MARGIN                598     677     764     860     959   1,077   1,196   1,290   1,392
```